HUDBAY

January 25, 2018

Mr. William James
National Mining Expert
Great Lakes and Ohio River Division
U.S. Army Corps of Engineers
3701 Bell Road
Nashville, Tennessee 37214-2660

Ms. Deanna Cummings
Senior Regulatory Project Manager
Albuquerque District
U.S. Army Corps of Engineers
4101 Jefferson Plaza NE
Albuquerque, NM 87109

Re: Response to EPA Analysis of the *Final Habitat Mitigation and Monitoring Plan,* dated September 12, 2017, EPA Comments October 5, 2017 (Revised November 30, 2017) Rosemont Copper Project, Clean Water Act Section 404 Permit, CoE File No.: 2008-00816-MB

Dear Mr. James and Ms. Cummings:

On December 1, 2017, the U.S. Army Corps of Engineers (Corps) transmitted a copy of EPA comments regarding our Habitat Mitigation and Monitoring Plan (HMMP) dated November 30, 2017 to Rosemont Copper (Rosemont). Since that time, Rosemont and its technical consultants, WestLand Resources, Water and Earth Technologies, and Tetra Tech, have been reviewing the document.

Rosemont specifically asked our consultants to ensure the HMMP presented was technically correct, that our assumptions were valid, and to ensure that EPA's concerns were addressed. We are pleased to be able to say that we believe EPA's concerns have already been addressed or were a misunderstanding of the information we presented. In some instances, we simply disagree with the information that was presented by the EPA and in others we believe their analysis is incorrect.

To facilitate the Corps' examination of the EPA comments against the HMMP we have prepared a response document (attached) that responds to the EPA comments, addresses their concerns, and even provides a bit of history regarding Sonoita Creek Ranch. The document mirrors, to the extent practicable, the presentation by EPA in their document.

Woven throughout the EPA document is the assumption that the HMMP as proposed was designed to "offset impacts to Waters of the U.S. below the level of significant degradation." The HMMP as proposed was consistent with the 2008 Mitigation Rule for the Corps to mitigate for fill activity associated with the project and the indirect impact of stormwater flow reduction caused by that fill. Rosemont does not believe that the EPA has provided the factual determination necessary to show significant degradation.

EPA's evaluation of the HMMP and the application of mitigation requirements would also appear to not match the Corps or the regulatory requirements for mitigation or project approval.

Two other documents, one discussing Significant Degradation Analysis and the other the Environmental Consequences of Groundwater Drawdown were also provided by the Corps on December 1. Rosemont is preparing responses to those documents and will provide them under separate cover in the near future.

If you have questions or require further information regarding this topic, I can be reached at (520) 495-3502 or via email at kathy.arnold@hudbayminerals.com.

Regards,

Katherine Ann Arnold

Katherine Ann Arnold, PE
Director, Environment

Attach: *Response to Environmental Protection Agency (2017) "The Mitigation Proposed by Rosemont Mine Will Not Offset Impacts to Waters of the U.S. below the Level of Significant Degradation"* WestLand Resources & Water and Earth Technologies, January 24, 2018

cc: File

Doc. No. 005/18-15.2.1

RESPONSE TO ENVIRONMENTAL PROTECTION AGENCY (2017)

"The Mitigation Proposed by Rosemont Mine Will Not Offset Impacts to Waters of the U.S. below the Level of Significant Degradation"

Prepared for:

Rosemont Copper Company
5255 East Williams Circle, Suite W1065 • Tucson, Arizona 85711

Project Number: 1049.117
January 24, 2018

Prepared by:

WestLand Resources

Water & Earth TECHNOLOGIES
Water Resources and Environmental Consulting

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1. INTRODUCTION

In a letter dated November 30, 2017, the Environmental Protection Agency (EPA) transmitted three separate memoranda to the U.S. Army Corps of Engineers (Corps) providing comments on the Rosemont Copper Project (the Project). In this report, we address comments contained in the memorandum titled "EPA Analysis of the *Final Habitat Mitigation and Monitoring Plan* [HMMP] *Permit NO. SPL-2008-00816-MB Rosemont Copper Project dated September 12, 2017*" (dated October 5, 2017, revised November 30, 2017) (EPA 2017).

In the memorandum, the EPA (2017) asserts that the, "*HMMP proposed by Rosemont fails to offset the proposed mine's impacts to aquatic resources in the Cienega Creek watershed.*" Threaded through the comments are two persistent themes that are not supported by the 2008 Mitigation Rule or the South Pacific Division (SPD) mitigation guidance. The first is that proposed mitigation elements should be of an identical aquatic resource type to the impacted resources. The second theme is the strong implication that if the proposed mitigation does not somehow *undo* the known or modeled potential impacts of the Rosemont Project, then the mitigation does not effectively compensate for those impacts. While both the 2008 Mitigation Rule and the SPD guidance articulate a preference for "in-kind" mitigation, they both recognize the value of mitigation that may be "out-of-kind" or at some distance from the impact site, and therefore leave the decision of appropriate mitigation to the District Engineer to determine on a project-by-project basis.

In this document, we demonstrate that the mitigation package for the Rosemont Project, described in the September 2017 HMMP, not only comports with the 2008 Mitigation Rule and the SPD guidance, but represents a singular opportunity to implement a landscape-scale restoration project of a significant ephemeral stream system that has been heavily manipulated for over a century. Although the comments provided by the EPA (2017) tend to be somewhat repetitive and disjointed, we have attempted to structure the responses in this report to mirror to the extent practicable the presentation by the EPA (2017).

2. SONOITA CREEK RANCH MITIGATION PARCEL

2.1. DEFINING COMPENSATORY MITIGATION

The EPA (2017) asserts that the HMMP makes use of incorrect terminology when referring to key mitigation elements, and therefore the mitigation ratio in the Mitigation Ratio Setting Checklist (MRSC) is calculated incorrectly. As an example, the EPA (2017) states that the restoration of the Sonoita Creek channel is more accurately described as *rehabilitation* rather than *reestablishment*, as described in the HMMP.

While we agree that the language in the 2008 Mitigation Rule is subtle, it is clear that the proposed realignment of Sonoita Creek qualifies as ***reestablishment***, defined in the 2008 Mitigation Rule as follows:

"…the manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former aquatic resource. Re-establishment results in rebuilding a former aquatic resource and results in a gain in aquatic resource area and functions."

The Sonoita Creek restoration project incorporates comprehensive manipulation to the Sonoita Creek stream channel that will repair historic straightening and ongoing incision, reconnect the channel to the floodplain and relocate the channel relative to its valley and away from confinement by infrastructure (**Figures 1 through 6**).

Figure 1. Rendering of Existing Sonoita Creek from Highway 82

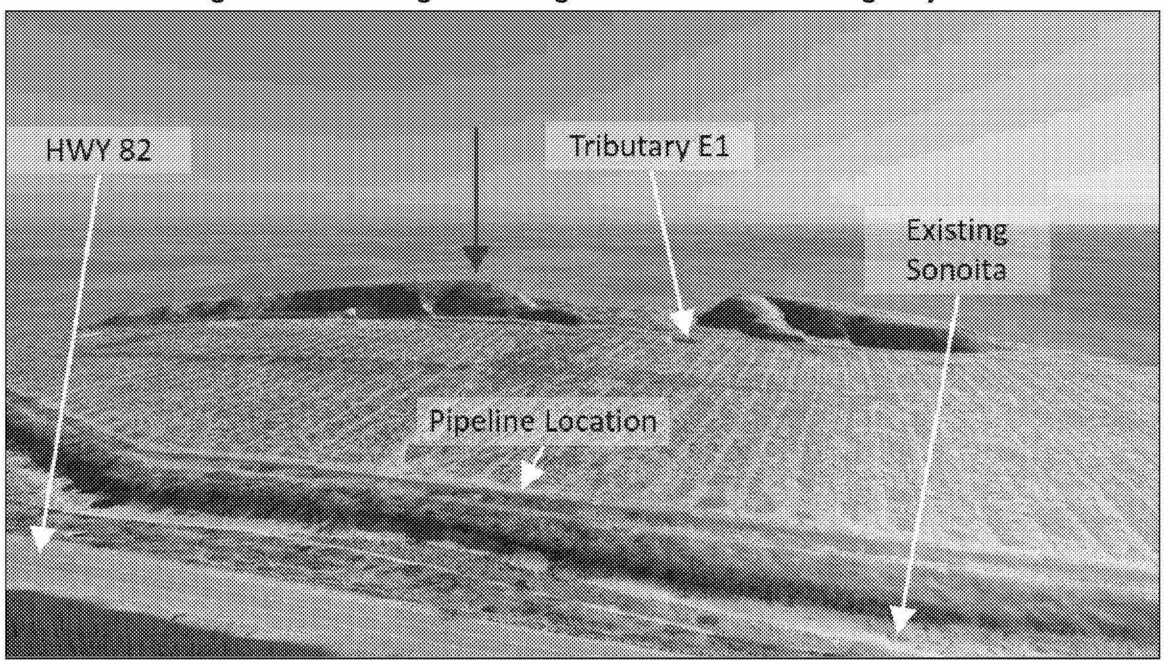


Figure 2. Rendering of Proposed Sonoita Creek from Highway 82

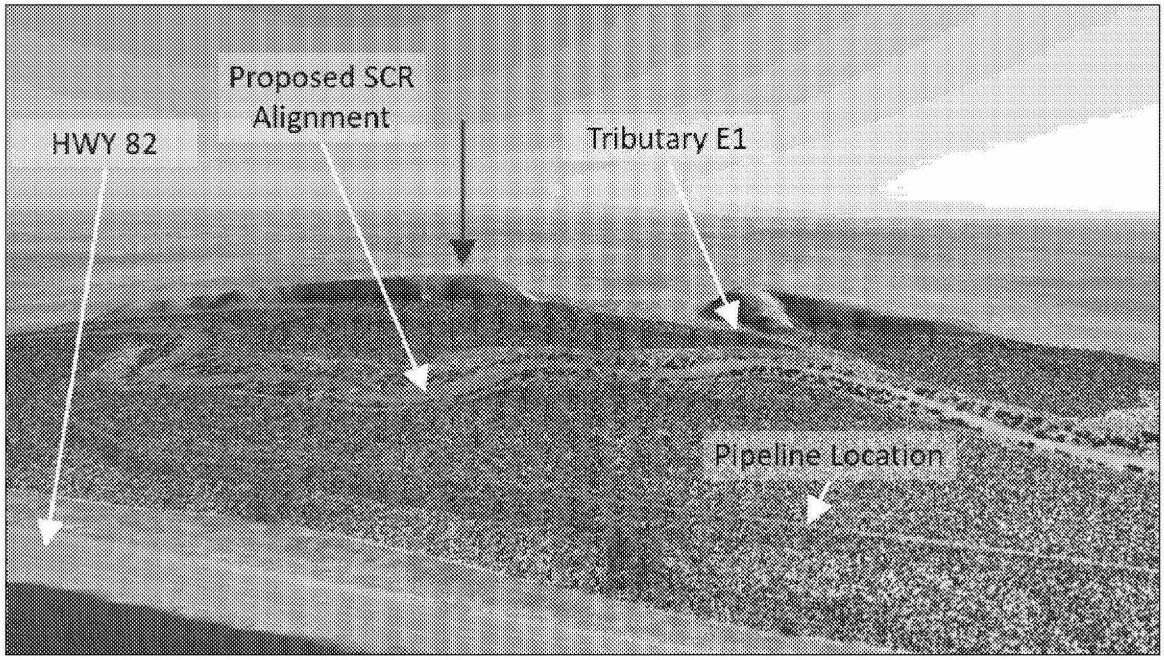


Figure 3. Rendering of Existing Sonoita Creek Valley Looking at Tributary E1

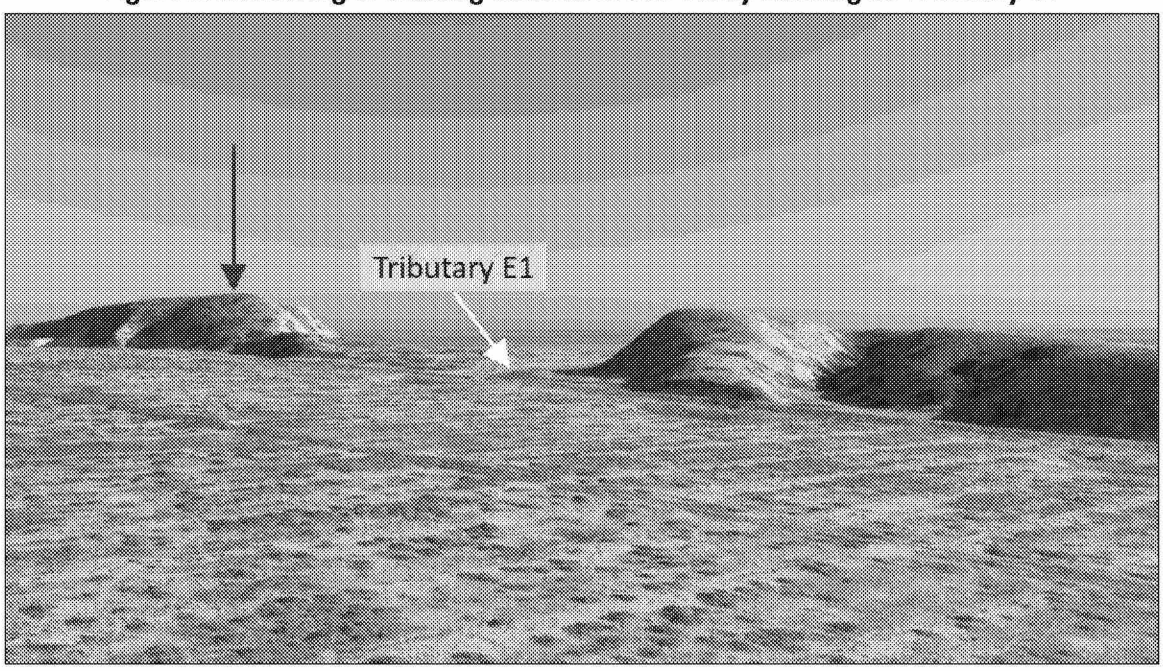


Figure 4. Rendering of Proposed Sonoita Creek Valley Looking at Tributary E1

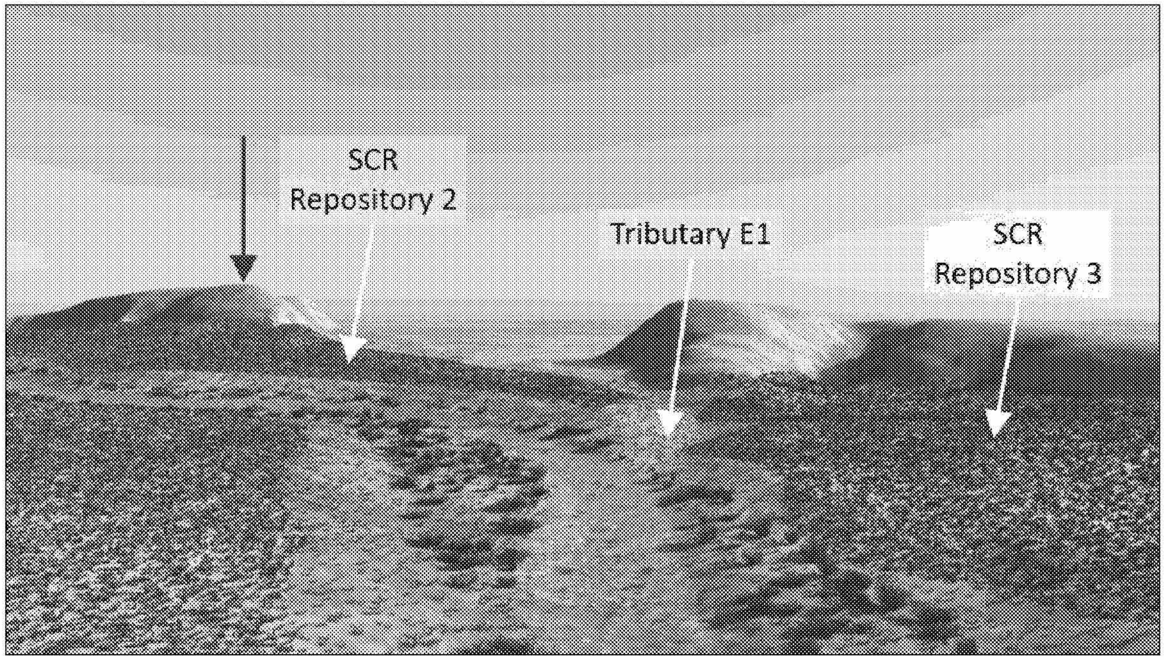


Figure 5. Rendering of Existing Agricultural Field near Pond 2

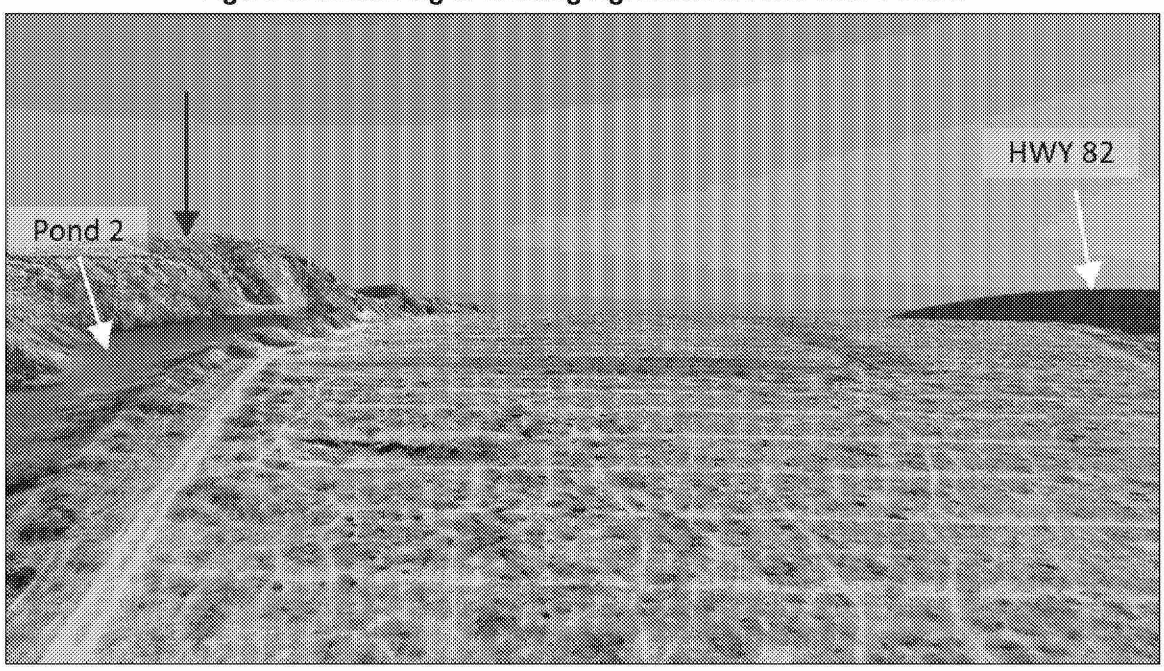
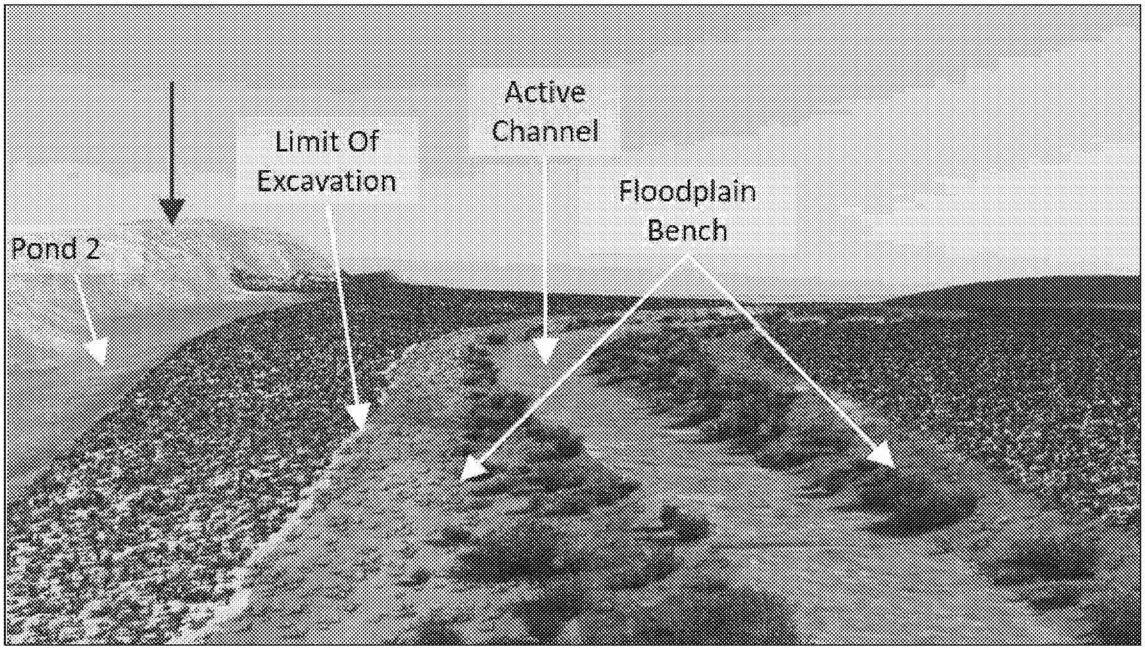


Figure 6. Rendering of Proposed Sonoita Creek and Reclaimed Agricultural Field near Pond 2



The proposed channel construction project restores the stream channel to its former location, resulting in a gain in aquatic resource area. That is, the aquatic resource (the stream channel) is being reestablished in the area it formerly occupied. Further discussion of the historic evidence of channelization of Sonoita Creek is provided in **Section 2.3**.

Response to the EPA's (2017) comments on the channel realignment project in relation to established reference reaches is provided in **Section 2.5**.

In what appears to be a non-sequitur, the EPA (2017) asserts that the design of the channel realignment project is "*unsustainable*," referencing only 33 CFR Parts 325 ("Processing of Department of the Army Permits") and 332 ("Compensatory Mitigation for Losses of Aquatic Resources"). Without further context, this comment is not particularly enlightening. However, it should be noted that the HMMP, and the responses provided in this report, provide substantial documentation of the design effort to ensure the sustainability of the restoration effort.

The EPA (2017) also disputes that the other ephemeral washes at the Sonoita Creek Ranch property would experience *enhancement* through the construction of wildlife-friendly and wildlife-barrier fencing around the mitigation parcels. *Enhancement* is defined in the 2008 Mitigation Rule as:

> "*…the manipulation of the physical, chemical, or biological characteristics of an aquatic resource to heighten, intensify, or improve* ***a specific aquatic resource function(s)*** [emphasis added]. *Enhancement results in the gain of selected aquatic resource function(s), but may also lead to a decline in other aquatic resource function(s). Enhancement does not result in a gain in aquatic resource area.*"

The wildlife habitat value of riparian areas associated with ephemeral wash systems is well established (Levick et al. 2008). By replacing the existing barbed wire fence with fence designed to facilitate the movement of wildlife through the parcel (Dolan and Mannan 2009; AGFD 2011), thereby enhancing and reinforcing the value of the mitigation parcel as a wildlife corridor, the value of the ephemeral washes within the mitigation parcels as wildlife habitat will have necessarily been enhanced. As such, enhancement credit for the existing ephemeral washes and associated buffer habitat is warranted.

2.2. Mitigation Outside Watershed of Rosemont Project

The EPA (2017) asserts that that the Sonoita Creek Ranch mitigation parcel "*lies outside the watershed where the Rosemont Mine project will be constructed and therefore, mitigation proposed at SCR [Sonoita Creek Ranch]/RX Ranch will not offset any direct or secondary impacts to aquatic resources within the Cienega Creek watershed.*" However, they acknowledge in a footnote that the mitigation parcel and the Rosemont Project both lie within sub-watersheds of the Santa Cruz River.

As noted in the introduction, this comment represents a recurring and erroneous theme in the EPA (2017) comments. That is, because the proposed mitigation does not somehow undo the modeled potential impacts of the Rosemont Project, that the mitigation is somehow inappropriate. While Rosemont recognizes that the preference of the Corps and the EPA, as described in the 2008 Mitigation Rule, is for compensatory mitigation to occur as near to the aquatic resources impacts as possible, the rule also recognizes that permit-specific circumstances may require mitigation to occur at some distance from the project impacts. The MRSC developed by the Corps South Pacific Division (12501.1-SPD) contemplates this precise scenario by including Step 4, Mitigation Site Location, which requires a ratio adjustment of +1 for mitigation elements that lie outside the Corps-defined watershed of the aquatic resource impacts.

As described in the HMMP (Section 4.1) Rosemont completed an exhaustive search for mitigation opportunities, emphasizing restoration, in the Cienega Creek watershed. No such opportunities were available.

The 2008 Mitigation Rule itself categorizes streams and washes as "*difficult to replace*" aquatic resources, and restoration opportunities for streams and washes, particularly ephemeral washes, are limited. Rosemont identified the substantial opportunity for landscape-scale restoration of a degraded ephemeral wash system at Sonoita Creek Ranch, in an adjoining (HUC 8) watershed. This mitigation parcel represents the most substantial ephemeral wash restoration opportunity in this part of the state, and is therefore an appropriate mitigation element for the Rosemont Project.

2.3. Assessment and Comparison of Functions of Water

In this section, EPA (2017) asserts that, "*The most serious underlying flaw with the HMMP's assessment of functions for the determination of mitigation credits is that it contains no quantitative functional assessment of waters at*

SCR, or the Rosemont Mine impact site. This fact alone limits the usefulness of this mostly speculative discussion in determining appropriate mitigation crediting."

The Corps' South Pacific Division (SPD) requires use of the 12501 Standard Operating Procedure for Determination of Mitigation Ratios to determine adequate compensatory mitigation for project impacts. Per 12501, functional assessments are to use a qualitative impact-mitigation comparison if no Corps-approved quantitative functional assessment is available. Because there is currently no quantitative functional assessment approved by the Corps for use in Arizona, qualitative analysis in the MRSC has been employed in the Rosemont HMMP.

The EPA (2017) also asserts the following:

> "*A recurring flaw in the current and previous versions of the Rosemont HMMP is the use of direct qualitative functional comparisons of Sonoita Creek with streams at the mine impact site. From a hydrogeomorphic perspective, Sonoita Creek and streams at the mine impact site are incommensurable, and therefore should not be judged by the same standard. It is widely understood within the scientific community that comparisons of aquatic functions are meaningful only when comparing waters within the same hydrogeomorphic class or sub-class.*"

This comment reflects the other recurring theme in the EPA (2017) comments. That is, if the impacted and mitigating aquatic resources are not of an identical type, then the functions of these resources cannot be compared, despite the fact that Step 2 of the MRSC allows for (even requires) just such a comparison. The EPA (2017) even provides a strained analogy about shotputs in an effort to illustrate the point, but comparisons of individual functions of similar, or even quite different, aquatic resources is allowed for (again, even required) by the SPD guidance.

In addition, it should be noted that the ephemeral washes at the Rosemont site are more similar to those at the Sonoita Creek Ranch mitigation parcel than they are different. While Barrel Canyon (the largest ephemeral wash at the Rosemont site) is relatively higher in the watershed and has shallower alluvium than Sonoita Creek, these differences are more a matter of degree than representing substantive distinctions. Both systems provide, for instance, sediment transport, groundwater infiltration, and wildlife habitat. And when considered over a regional scale, the differences between Barrel Canyon and Sonoita Creek are details between sub-classes of ephemeral streams proximally located in the same region. As such, the Sonoita Creek restoration project provides in-kind mitigation for the impacts resulting from the Rosemont Project.

At the end of this section, the EPA (2017) presents a series of additional comments which are addressed individually below. EPA comments are provided in *italics*; our responses are provided in standard text.

1. *Comment: The HMMP states:* The reestablished riparian floodplain system, including ephemeral channels and associated riparian habitat, have been designed to replicate, to the extent practicable, the form and function (gradient, sinuosity, composition, etc.) of the previous system that existed

within the Sonoita Creek floodplain prior to the channelization of Sonoita Creek into its current configuration. *Existing evidence supports the conclusion that Sonoita Creek was a single thread channel that was much less sinuous than the proposed reestablished channel design.*

Response: Here, the EPA (2017) provides a footnote reference to Kondolf and Ashby (2015), and a note regarding the supposed evidence provided by the review of a 1935 aerial photograph of the Sonoita Creek Ranch mitigation parcel. However, as noted in the discussion below, there is substantial evidence that the intense channelization of Sonoita Creek flows occurred as far back as the 1860's, or earlier.

Historical and recent times in southern Arizona have witnessed enormous changes in streamflow regimes throughout the area. One of the most notable changes consists of widespread arroyo downcutting, resulting in incised stream channels (Betancourt 1990; Webb, Leake, and Turner 2007). For example, downcutting leading to incision began along stretches of the Santa Cruz River by the 1870s, and had progressed to the point that the entire channel was incised by the 1930s (Betancourt 1990; Logan 2002; Webb, Leake, and Turner 2007). Similar changes appear to have occurred along Sonoita Creek, which is now largely incised in a deep channel.

Research indicates that the present regime along the stretch of Sonoita Creek within and near the Sonoita Creek Ranch parcels has been in place since at least the mid-1800s, when historic human modification of the natural streamflow regime began. The first modification of the stream likely occurred during the Mexican Period (A.D. 1821-1854), when the San José de Sonoita Land Grant was created and issued to León Herreros, a resident of Tubac (Bowden 2018). While no specific record of modifications to the stream during Mexican times are known, by the time of the first detailed American map of the area – an 1869 map of the Camp Crittenden Military Reservation (**Appendix A**) – human-induced changes to the flow of the creek are readily apparent. Along the north edge of what would later be the Sonoita Creek Ranch North Parcel (of the Rail X Ranch), the natural creek channel is shown diverted into two ditches labeled "acequia," one along the eastern side of the valley floor and the other along the western side. These acequias – which flank floodplain fields labeled as "cultivated" – would have been irrigation canals, likely created by Hispanic farmers working the land grant. This suggests that a similar approach to irrigation was taken here as was used in the nearby Santa Cruz River Valley on the "Baca Float No. 3" land grant near Tubac, which was granted to the heirs of Luis Maria del Baca in 1863 (Sheridan 2006).

In the Baca Float No. 3 and farther north in Tucson, early Hispanic farmers used acequias to water crops. It is noteworthy that the creation of these acequias required surface flow, and canal systems were constructed so as to draw water locations where water was forced to the surface at bedrock constrictions (Webb, Leake, and Turner 2007). Indeed, a shallow, meandering stream – as opposed to an entrenched, downcut channel – was needed by the early Hispanic farmers to capture water in the canal headgates at the level of the floodplain (Logan 2002). By analogy, it is suggested here that Sonoita Creek just north of Monkey Canyon and Adobe Canyon must have had a similarly shallow cross-sectional profile for the diversion of water into the two acequias shown on the 1869 map of Fort Crittenden.

During the subsequent period of early American settlement in the Sonoita and Patagonia areas, modification of the stream channel system continued. An 1877 General Land Office (GLO) plat of Township 21 South, Range 16 East of the Gila and Salt River Baseline and Meridian shows that the pattern of irrigation continued in the Sonoita Creek Ranch parcels. In this case, one ditch is shown in the South Parcel, apparently toward the eastern side of the valley (**Appendix B**). In 1897, a new GLO plat shows the same feature in both the North and South Parcel, clearly labeled as "Irrigating Ditch" (**Appendix C**). In both cases, no streambed or drainage is shown, suggesting that Sonoita Creek flows had been channelized into the irrigation ditches at the time of the GLO surveys in 1876 and 1888.

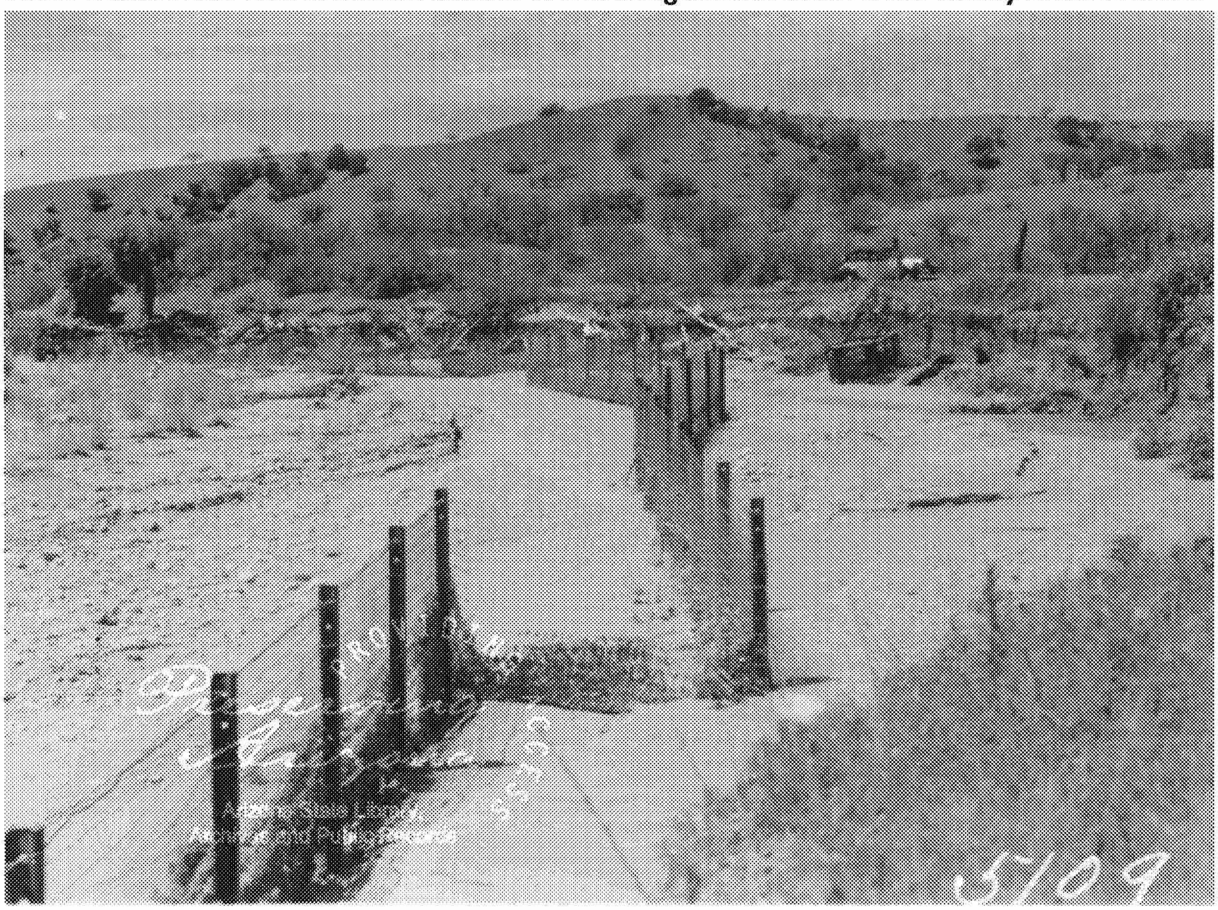
Modification of water resources in the area continued under the regime of American ranchers who settled the area in the 1890s and early 1900s. In the February 22, 1890 edition of the Arizona Weekly Citizen, a travelogue describing the area around the village of Crittenden was printed. This short article describes a ranch in the "possession of Messrs. Richardson and Gormley." This large ranch was the Pennsylvania Ranch, founded by Rollin R. Richardson and T. H. Gormley around 1890, and known today as the Rail-X Ranch. The article states that "ditches have been excavated through the land intended for cultivation—one on either side of the valley and one in the center" suggesting again that the Sonoita Creek channel itself had been heavily manipulated by these efforts.

In 1901, Richardson, founder of the Crittenden Land and Cattle Company and the Pennsylvania Ranch, sold his interest in the company and his land to a consortium headed by Walter S. Vail of the Empire Ranch. In the bill of sale, it is noted that one Scott S. McKeown owned a half interest in a windmill "on the Pennsylvania Ranch near the ranch house" and a half interest in a pipeline to the tank at the house and a pipeline from Monkey Springs. This suggests that McKeown and Richardson had collaborated to build a well and tank on the valley floor near where the Rail-X Ranch house stands today and to divert water from "Monkey Springs reservoir No. 2" to a reservoir near McKeown's own house. These mentions of water management indicate that active management of streamflows and underground water continued during the early period of Anglo-American use of the area.

On September 17, 1903, the Crittenden Land and Cattle Company (now owned by Walter S. Vail's consortium) met in Los Angeles. The minutes of the meeting record that Oscar F. Ashburn, a member of the board and the ranch manager, was instructed "to appropriate for and on behalf of this corporation all springs, streams and water courses that he may consider of use and benefit to it" and to "build the dams, lay and construct the pipe lines, flumes, and ditches, and erect and construct the necessary tanks, reservoirs, and fences for the diversion, use, storage, and protection of said waters."

As described previously, Anglo-American water management policies and practices lead to widespread downcutting along the Santa Cruz River, and there is evidence that similar changes had occurred along Sonoita Creek by the 1930s. A photograph believed to have been taken in the late 1930s in the vicinity of Rail-X Ranch shows that the stream had downcut and become incised by this point, and work was underway to construct gabions to reduce further erosion and protect State Route 82 (SR 82) (**Photo 1**). This shows that at least 60 years of Hispanic and Anglo-American water management practices had created an incised stream along this stretch of Sonoita Creek.

Photo 1. Late 1930s View of Erosion Control Works along Sonoita Creek in the Vicinity of Rail-X Ranch



Taken together, these sources present strong evidence for Hispanic and Anglo-American modification of this stretch of the Sonoita Creek Valley going back, at a minimum, to 1869.

2. *Comment: Page 41 of the HMMP provides comparisons of various physical features (e.g., floodplain width, depth of alluvium, watershed size) of Sonoita Creek and streams at the mine site. These comparisons support the above contention that waters at the two sites differ significantly and are in different hydrogeomorphic subclasses.*

Response: As noted above, the ephemeral washes at the Rosemont site and those at the Sonoita Creek Ranch mitigation parcel occupy the same broad class of aquatic resource as contemplated by the 2008 Mitigation Rule ["(e.g., forested wetlands, perennial streams)" (73 FR 19601)], as well as the same sub-class of regional ephemeral wash. They also provide similar types of function, e.g., sediment transport, groundwater recharge, wildlife habitat. For all of these reasons, the Sonoita Creek restoration project provides in-kind mitigation for Rosemont Project impacts.

3. *Comment: The HMMP states:* As described elsewhere in this HMMP, the channelized reaches of Sonoita Creek are currently performing most functions poorly… *There is no quantitative functional assessment of the current functions of Sonoita Creek upon which to base this speculative statement.*

   Response: As noted above, a Corps-approved quantitative functional assessment does not currently exist for the ephemeral systems in Arizona. In addition, given the highly degraded state of Sonoita Creek as it occurs in the mitigation parcel, as described in the HMMP, Attachment 2, a formal quantitative functional assessment is not necessary to document the degraded state of the creek.

4. *Comment: The HMMP states:* The 2008 Mitigation Rule allows for mitigation credit for non-aquatic riparian buffer habitat where necessary to ensure the long-term viability of aquatic resources (33 C.F.R. § 332.3(i)), and that is certainly the case for the reestablished riparian habitat within the Sonoita Creek floodplain. It is important to note that this mitigation component goes well beyond the simple "preservation" of buffer habitat. *The Mitigation Rule states that* Non-aquatic resources *[including riparian areas, buffers, and uplands]* can only be used as compensatory mitigation for impacts to aquatic resources authorized by DA permits when those resources are **essential** to maintaining the ecological viability of adjoining aquatic resources. *[emphasis added]* The Mitigation Rule further defines buffer as …an upland, wetland, and/or riparian area that protects and/or enhances aquatic resource functions associated with wetlands, rivers, streams…from **disturbances associated with adjacent land uses**. *[emphasis added] The proposed reestablished Sonoita Creek channel will lie in the center of a large preserved parcel that is not threatened by adjacent land uses. As such, buffer functions will be provided by* simple preservation *of the floodplain. Awarding additional mitigation credits for buffer habitat functions that are already being met through preservation is not consistent with either the definition of buffer, or the meaning of* essential *within the context of the Mitigation Rule.*

   Response: This comment disregards the level of riparian floodplain restoration that is proposed along the reestablished Sonoita Creek through the agricultural fields that have been in place for well over a century. As described in the HMMP, and as seen by EPA during multiple site visits, the mitigation parcel is dominated by a series of agricultural fields that have been in place since at least the mid-19th century, and that are currently dominated by exotic Johnson grass. By reestablishing the natural flow channel for Sonoita Creek through this substantially human-altered landscape, including the removal of inadequate infrastructure, and replacement of invasive vegetation with local species, Rosemont will be returning a significant ephemeral wash system, including the associated xeroriparian habitat, to a more natural and functional state.

5. *Comment: The HMMP states:* Rehabilitation of the Sonoita Creek channel will result in a more stable channel, thereby reducing bank erosion and excessive sediment transport while promoting groundwater infiltration and wildlife habitat development. *There has been no analysis supporting the contention that Sonoita Creek suffers from excessive bank erosion or sediment transport (refer to discussion that follows below on bank erosion, and sediment transport and deposition in Sonoita Creek). The existing Sonoita Creek is a losing stream and already promotes groundwater infiltration.*

   Response: See **Section 2.7** for a full discussion on the compromised, degraded condition of the existing Sonoita Creek.

6. *Comment: The HMMP states:* Enhancement of all onsite ephemeral washes and riparian buffer (including the existing Sonoita Creek channel, Corral Canyon, and the other tributaries on the east side of the property) will be accomplished by the construction of wildlife- friendly fence and exclusion of livestock grazing. The functions to be enhanced within the potential WOTUS at Sonoita Creek Ranch as a result of the exclusion of grazing are wildlife connectivity (through the construction of wildlife-friendly fencing) and wildlife habitat (through the anticipated modest increase in forage production). *As discussed in more detail, below, there is no quantitative functional/ condition assessment of the ephemeral waters proposed for fencing, nor for the functions allegedly enhanced.*

   Response: As noted in **Section 2.3**, a Corps-approved quantitative functional assessment does not currently exist for the ephemeral systems in Arizona. In addition, and as indicated in **Section 2.1**, the function to be enhanced through the installation of wildlife-friendly and wildlife-barrier fencing around the Sonoita Creek Ranch mitigation parcel is to facilitate the safe movement of wildlife through the mitigation parcel, reinforcing the value of the parcel as a wildlife movement corridor. While some increase in vegetative cover would be expected to occur as a result of removing livestock grazing from the parcel, the proposed enhancement to the ephemeral washes and associated buffer habitat would be the facilitation of wildlife movement through these aquatic resources.

7. *Comment: The HMMP states:* As noted in the preamble to the 2008 Mitigation Rule, "[t]he term 'in-kind' in § 332.2 [§ 230.92] is defined to include similarity in structural and functional type; therefore, the focus of the in-kind preference is on classes of aquatic resources (e.g., forested wetlands, perennial streams)." (73 FR 19601). As such, any mitigation that includes ephemeral washes (the class of aquatic resource impacted at the Project Site) would be considered in-kind by the Rule. *This interpretation of the definition of in-kind in the Mitigation Rule is not correct and is not scientifically valid. It is indisputable that the structural and functional types of aquatic resources at the mine site are different from Sonoita Creek. To state otherwise demonstrates a complete lack of understanding of the structure and function of these waters at both sites. By the same logic presented in the HMMP, a farm pond would be comparable to Lake Tahoe because they are both lacustrine classes.*

   Response: The similarities between the functions of the ephemeral wash systems at the Rosemont Project site and the Sonoita Creek Ranch mitigation site have been outlined in item 2 of this section. These systems are similar enough in character to readily provide functional comparisons. The implication that the relationship between the ephemeral washes at the Rosemont Project site and those at the Sonoita Creek Ranch mitigation parcel is comparable to that between Lake Tahoe and a farm pond is obviously absurd and effectively serves to undercut the EPA's (2017) assertion.

8. *Comment: The HMMP states:* Rare or regionally-significant habitat types in southern Arizona would include perennial water features, such as the ponds at Sonoita Creek Ranch and the perennial systems at the LSPRWA [Lower San Pedro River Wildlife Area] ILF [in-lieu-fee] Project. The aquatic resources to be impacted at the Rosemont Project are almost exclusively ephemeral washes. **These washes do not represent rare or regionally significant habitat types as ephemeral washes are common in southern Arizona**. *[emphasis added] This statement and similar statements in the HMMP demonstrates a lack of understanding of the critical importance of the watershed at the mine site to the maintenance of perennial flows, riparian wetlands and drinking water supplies within the Cienega Creek watershed. It is undisputed that the washes at the mine site provide surface flow and recharge functions that support miles of perennial stream and many acres of riparian wetland critical to endangered fish and wildlife downstream from the project site within the Cienega Creek watershed.*

   Response: While we do recognize the functions that ephemeral washes perform within the 17 square-mile watershed surrounding the Rosemont Project area, we also understand that these washes are similar to a multitude of higher elevation washes that occur throughout the 457-square-mile Cienega Creek watershed and in other Sky Islands of southern Arizona. By comparison, the opportunity to restore an ephemeral wash system of the scale provided at SCR, including flows to a substantial perennial water source (Monkey Spring), is unquestionably rare.

9. *Comment: The HMMP states:* The enhanced ephemeral washes and associated buffer habitat are comparable to the smaller washes associated with the Rosemont impact site, and therefore represent in-kind mitigation. *As discussed in detail above, the proposed mitigation at SCR is almost exclusively out-of-kind.*

   Response: Again, the similarities between the impacted and mitigating ephemeral wash systems allow for a reasonable comparison of functions. While some mitigation elements do indeed represent out-of-kind mitigation (e.g., mitigation of the small washes at the Rosemont site with the perennial ponds at the Sonoita Creek Ranch mitigation parcel), these comparisons are relatively rare and contemplated by the 2008 Mitigation Rule and SPD MRSC.

2.4. Adequate Assessment and Mitigation for Impacts to Existing Functioning Waters, Floodplains, and Buffers

The EPA (2017) asserts in this section that, "*a total of at least 153 acres of existing channel, riparian and floodplain habitat will be impacted by implementation of the HMMP at SCR/RX Ranch. These impacts have not been adequately assessed and there is no mitigation proposed for several of the impacted habitats. In addition, impacts to buffer and other upland habitats at the mine site have not been mitigated.*"

Despite the EPA's (2017) assertions, both the Corps and the EPA understand that Rosemont is required to provide compensatory mitigation for impacts to waters of the U.S. (WOTUS), both at the Rosemont Project site (40.4 acres) and the Sonoita Creek Ranch mitigation parcel (8.9 acres). Impacts to areas outside the delineated WOTUS (i.e., outside the ordinary high water mark of the delineated channels), including impacts to riparian habitat and associated buffer, do not require compensatory mitigation per the 2008 Mitigation Rule.

2.5. The Use of Reference Reaches as a Design Guide for SCR/RX Channel Reestablishment

The EPA (2017) references a letter written by Pima County to the Arizona Department of Environmental Quality (ADEQ) that suggests that Walnut Gulch is an inappropriate reference channel for Sonoita Creek design. In the letter, Pima County dismisses comparisons between Walnut Gulch and Sonoita Creek due to differences in the underlying water table and topography (Sonoita Creek is highly connected to adjacent mountains, while Pima County asserts that Walnut Gulch is not connected to higher elevation mountain blocks). Further, Pima County suggests that the 1936 air photo may shed light on the pre-development channel alignments of Sonoita Creek.

Walnut Gulch and Sonoita Creek have different interactions with local groundwater as well as topographical and geological differences. However, the many similarities between the two channels should not be discounted due to the differing groundwater interactions. The reaches of Walnut Gulch that were compared to the Sonoita Creek designs have comparable watershed areas, channel gradients, elevations and channel substrate. Furthermore, since these sites are in close proximity (approximately 40 miles apart) and at similar elevation, it is reasonable to expect similar precipitation patterns, which is why Walnut Gulch was initially used as a reference for hydrologic analysis. The long-term rainfall measurements and discharge records at Walnut Gulch were analyzed for flood recurrences to provide a real-world, empirical confirmation of the theoretically estimated peak flows and recurrence intervals developed for Sonoita Creek. Given that the primary driver of hydrology, watershed area, is so close to Sonoita Creek, considering that Walnut Gulch has the longest and most complete suite of hydrologic data for arid ephemeral streams, and considering the close proximity to the design site, it is reasonable to compare Walnut Gulch flood flows to Sonoita Creek.

After establishing that the recurrence and magnitude of discharges at Walnut Gulch are comparable to the Sonoita Creek design assumptions, and considering that Walnut Gulch has a similar channel gradient to Sonoita Creek, the channel width data for Walnut Gulch was compared to SCR mitigation project design widths. Because channel width is related to discharge, and since measured discharge at Walnut Gulch is comparable to predicted discharge at Sonoita Creek, this analysis was used to corroborate the proposed channel width developed using downstream hydraulic geometry relationships from reference reaches in Sonoita Creek. The SCR channel designs did not use Walnut Gulch channel geometry as strict design criteria, although channel widths are largely comparable. Walnut Gulch was one among several lines of evidence supporting hydrology and channel geometry designs for Sonoita Creek. While Walnut Gulch was not used as the sole reference or as a strict template for designs at Sonoita Creek, it does share many similarities with Sonoita Creek, and is appropriate for comparison to Sonoita Creek restoration designs.

For clarification, sinuosity measurements of Walnut Gulch were not presented in the HMMP. Walnut Gulch is significantly more confined by local geology/topography than Sonoita Creek and should not be expected to exhibit the same sinuosity.

The EPA compared the sinuosity of existing Sonoita Creek with the RX and SCR Channels proposed in the HMMP, and asserts that the proposed channels have excessively high channel sinuosity, exceeding average sinuosity of the reference reaches by 22 to 35 percent. The EPA also concludes that since the proposed channels should have 30 percent lower sinuosity, then 30 percent less credit should be issued for reestablishment. Furthermore, the EPA concludes that the HMMP maximizes sinuosity in order to maximize reestablishment credit in excess of what is appropriate for this geomorphic setting.

More sinuosity measurements of the existing and proposed configurations of Sonoita Creek are presented for this response than in the HMMP, and they support the design sinuosity as proposed. The least altered, and most functional, dynamic reaches of Sonoita Creek and its tributaries, are not well represented by any single, uniform value of sinuosity, such as the 1.13 value presented by the EPA. Measured sinuosity of the proposed channels is within the measured range of sinuosity for the least-altered reaches of Sonoita Creek, Adobe Canyon, and Big Casa Blanca Canyon (**Table 1**; **Figures 7 through 10**). Average measured sinuosity of the proposed SCR Channel is 1.21, but the sinuosity measurements range from 1.09 to 1.34 (**Figure 9**), which is within the range of observed sinuosity for existing, functional and dynamic reaches of Sonoita Creek and its tributaries.

Table 1. Existing Sonoita Creek and Proposed SCR Channel Sinuosity Comparison

Stream Channel	Measured Sinuosity Range
Existing Sonoita Creek, Adobe Canyon, Big Casa Blanca Canyon	1.06 - 1.63
Proposed SCR Channel	1.09 - 1.34

The proposed channel planforms are valid from a scientific and engineering perspective, and considered several factors:

1. The proposed channel sinuosity falls within measured sinuosity of functional reaches of Sonoita Creek and its tributaries onsite.
2. Sinuosity also impacts channel gradient, and the proposed channels were designed to avoid creating nick points at the upstream and downstream junctions with existing Sonoita Creek.

3. The proposed channel sinuosity is higher than artificially straightened reaches of Sonoita Creek, which results in a slightly flatter longitudinal channel gradient that reduces specific stream power. The straightened portions of Sonoita Creek show evidence of channel incision which limits floodplain access. One of the goals of the Sonoita Creek restoration project is to reestablish floodplain access that is limited due to artificial manipulation.
4. The natural drainage pattern of three artificially disconnected tributaries to Sonoita Creek will be reestablished. The location and watershed characteristics of tributary channels also impact the receiving channel planform. The reestablished interaction between these tributaries and Sonoita Creek creates additional opportunities for channel meanders which can elevate sinuosity.
5. The proposed channels were intentionally designed with variations in channel cross-section and planform (sinuosity). The geometric variability (channel complexity) designed for the proposed channels is supported by onsite measurements of existing Sonoita Creek and its tributaries, and offers greater functional benefits than a reestablished channel constructed with a single, uniform sinuosity.

Restoring naturally variable conditions are encouraged in the 2015 South Pacific Regional Compensatory Mitigation and Monitoring Guidelines (Corps 2015). Moreover, oversimplifying the channel design with a single uniform sinuosity of 1.13 results in a less complex and dynamic channel, provides less functional lift than the channels as proposed in the HMMP, and is not consistent with the functional, dynamic reaches of Sonoita Creek and its tributaries that have a range of channel sinuosity and complex channel planforms.

Figure 7. Sinuosity Measurements on Big Casa Blanca Canyon

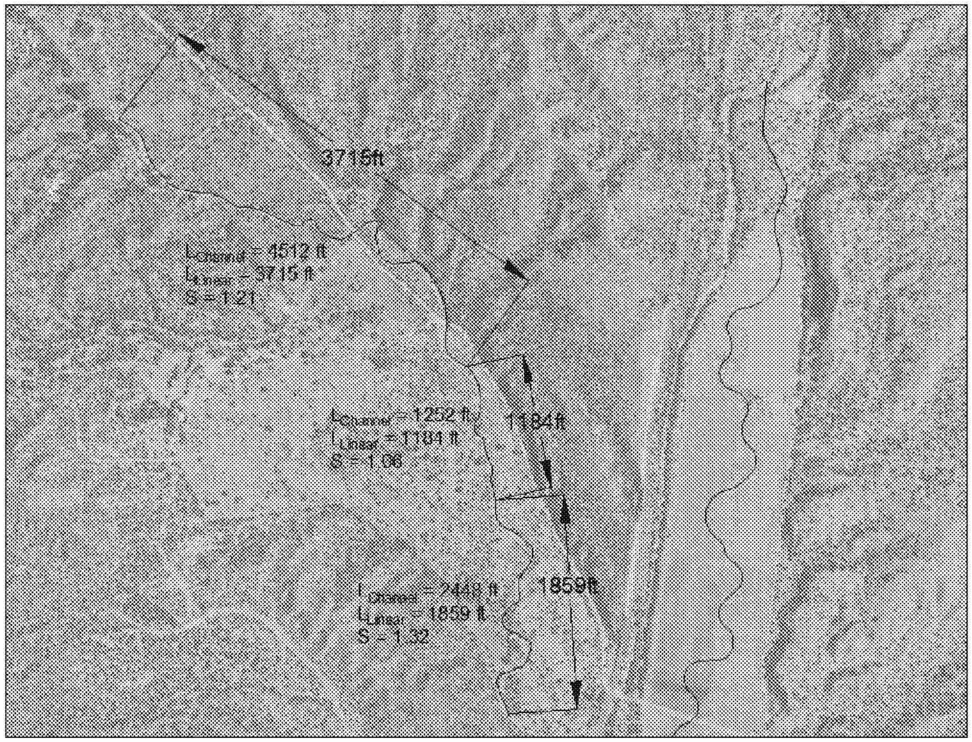


Figure 8. Existing Sonoita Creek Sinuosity Measurements

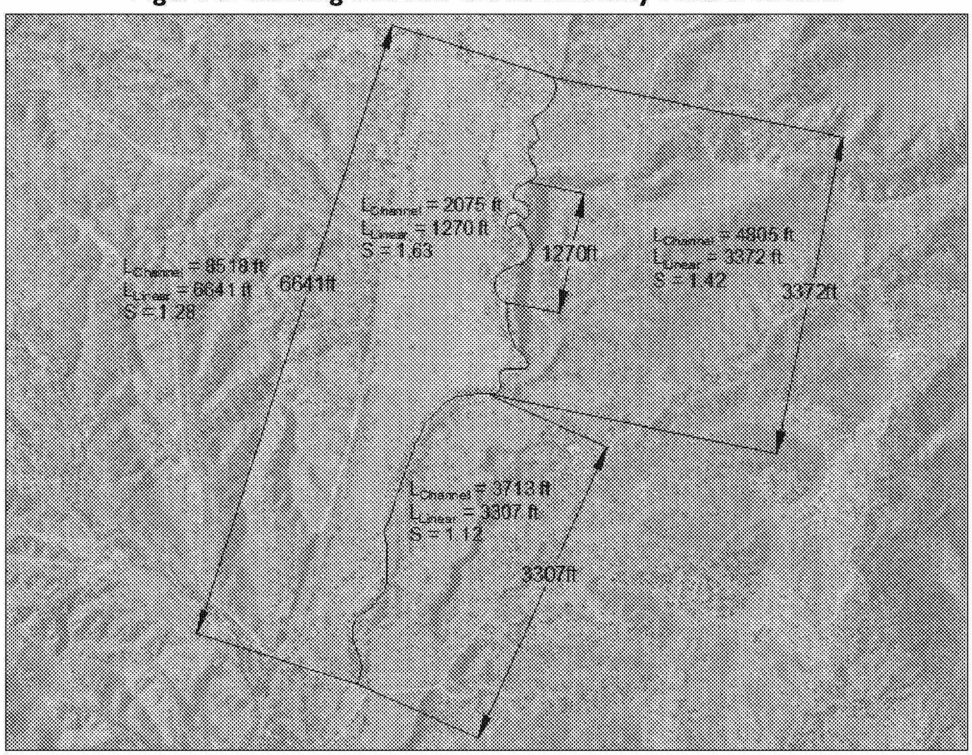


Figure 9. SCR Channel Sinuosity Measurements

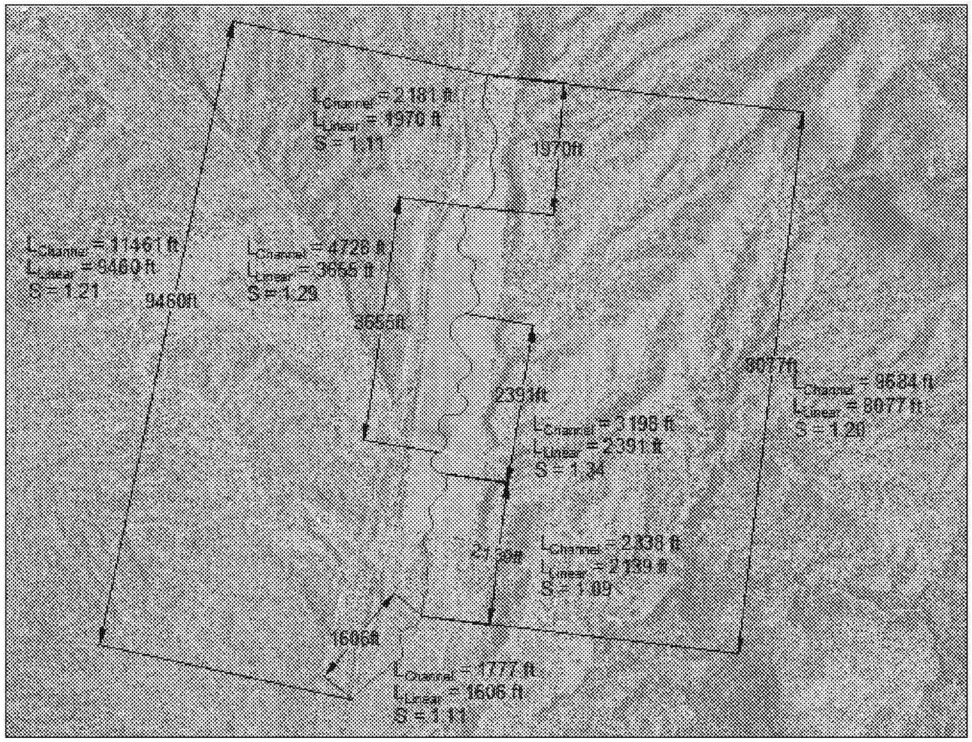
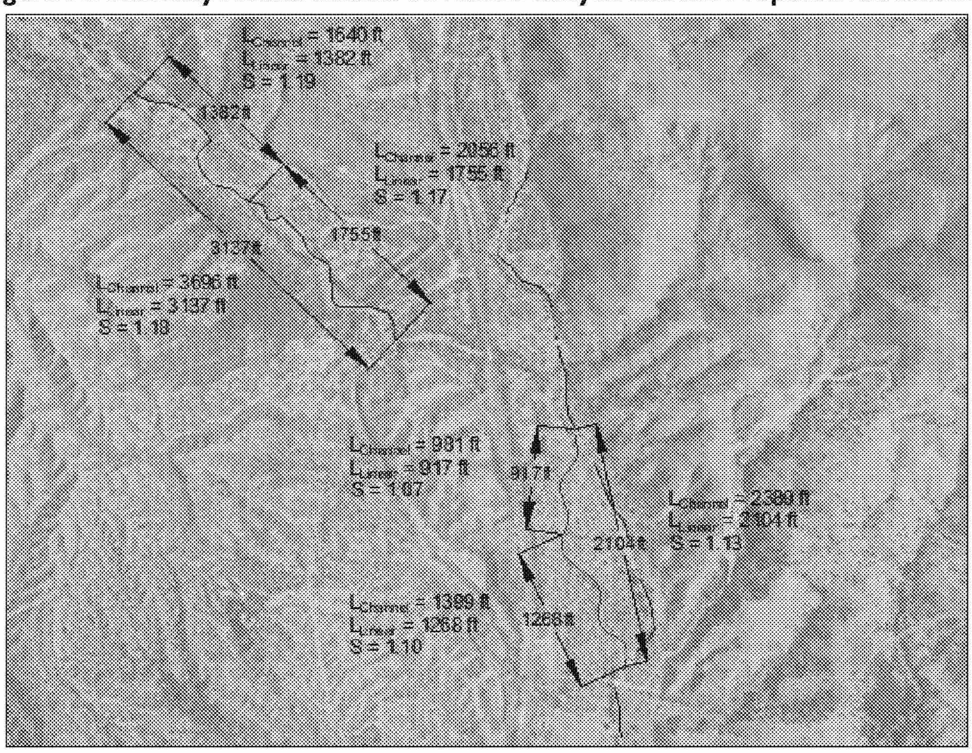


Figure 10. Sinuosity Measurements on Adobe Canyon and the Proposed RX Channel



Another point in need of clarification is that the proposed channels are designed with compound form, including the dominant channel shape, and an active channel nested inside the overall channel form. Thus, the sinuosity for the inundated water surface (during a 5-year storm) is related to, but different than, the sinuosity of the active channel nested within the dominant channel. The dominant sinuosity corresponds to sinuosity of the centerline of flood inundation during the 5-year storm event. Both the RX and SCR channels are designed with compound channel geometry that includes floodplain benches that vary in width through the channel bends. For instance, on the inside of a bend, the floodplain bench width increases, and on an outside bend, the floodplain bench width decreases. The effect is that significant storm events with a flow depth greater than 2-feet deep will have a straighter, less sinuous flow path (**Figure 10**).

The inundated flow area (i.e., the 5-year flood area and the area for which mitigation acreage was calculated) will have a lower channel sinuosity than the active channel centerline. For instance, that reach of the SCR Channel with a sinuosity of 1.34 as measured from the active channel centerline has a lower dominant sinuosity of 1.19, and the overall measurement of the entire SCR Channel has an active channel sinuosity of 1.21, and a dominant sinuosity of only 1.13 (**Figure 11**). This approach demonstrates that sinuosity was informed by scientific and engineering principles rather than an attempt to maximize mitigation credit.

The proposed channel planforms are designed with multiple considerations rather than a single measure of sinuosity, and are supported by scientific considerations. The variable sinuosity proposed in the HMMP is better supported by onsite references than a uniform sinuosity value of 1.13 as suggested by the EPA. Furthermore, the dominant sinuosity measured from the inundated surface is 1.13 for the overall SCR Channel, which is equivalent to the sinuosity proposed by EPA, and was not maximized to gain additional mitigation credit.

Figure 11. Dominant Channel Centerline and Active Channel Centerline

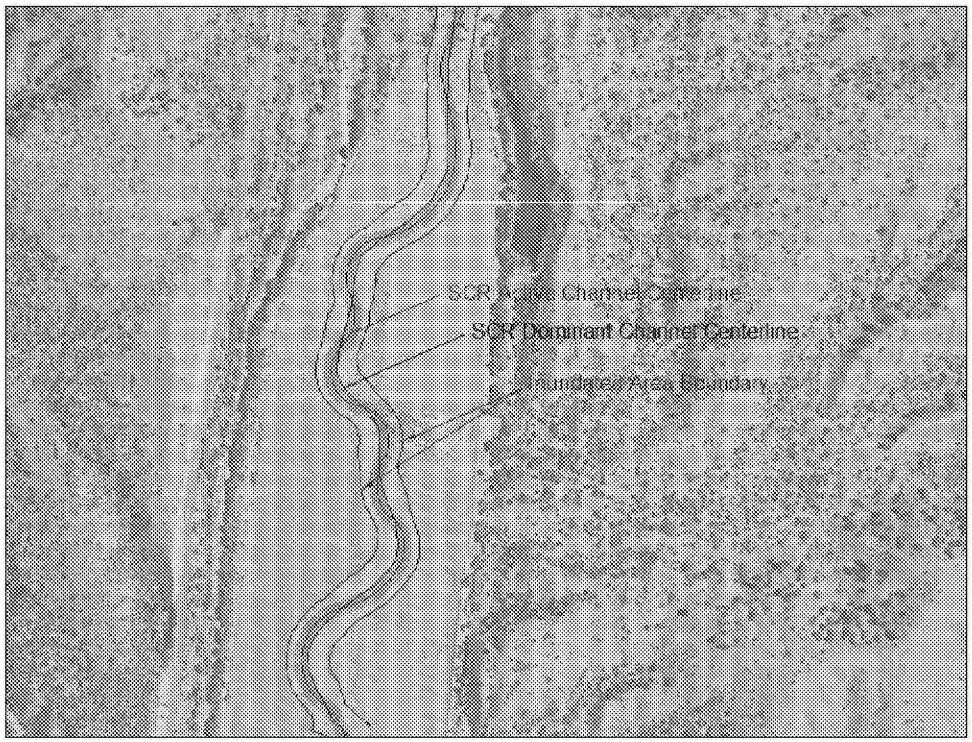
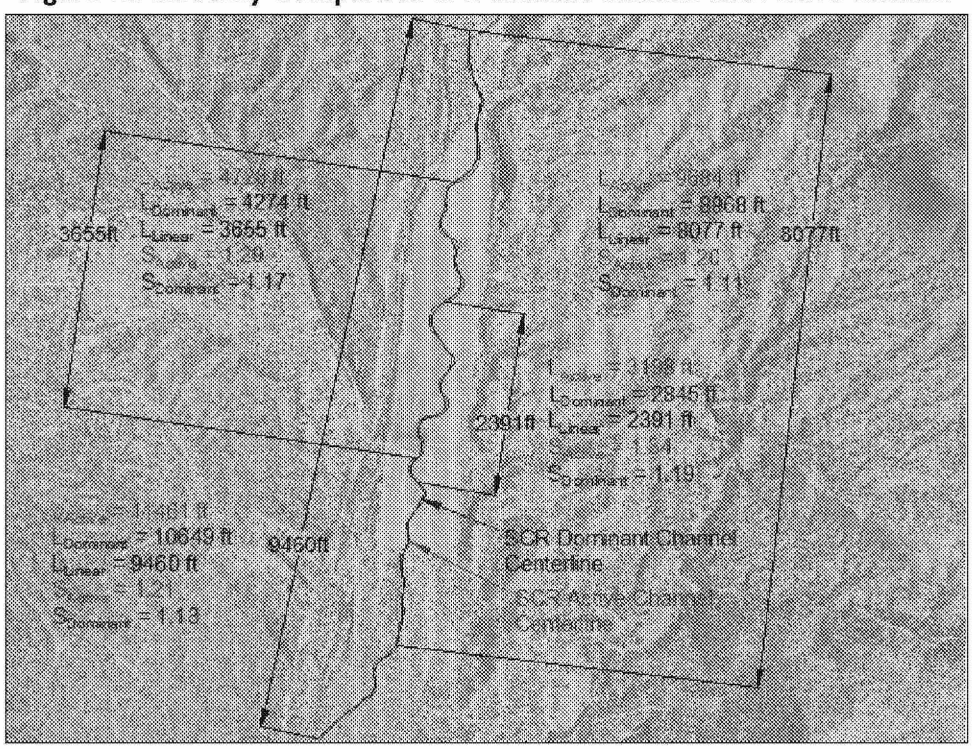


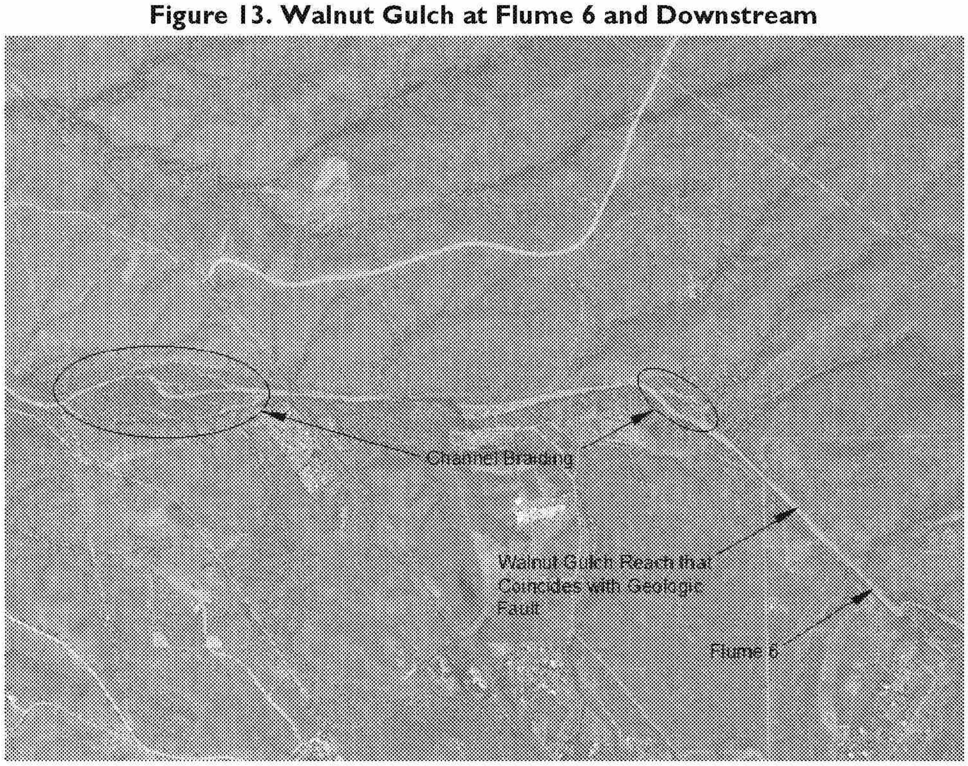
Figure 12. Sinuosity Comparison of Dominant Channel and Active Channel



The EPA (2017) states that the HMMP (Exhibit 1) depicts Walnut Gulch from Flume 7 to Flume 1 and further states that Walnut Gulch does not exhibit any braiding patterns between Flume 6 and Flume 2, which demonstrates that Sonoita Creek will likely not exhibit any braiding patterns. The EPA also notes that the reach from Flume 7 to Flume 1 has significantly greater watershed area, tributary inputs, and channel dimensions than the upstream reach between Flume 2 and Flume 6.

The HMMP (Exhibit 1) depicts Walnut Gulch between Flume 2 and Flume 1 as well as downstream of Flume 1, and depicts a tributary to Walnut Gulch at Flume 7. The majority of channel braiding occurs along this reach of Walnut Gulch; this is not the same reach for which hydrologic analyses were conducted and results compared with recurrence intervals and peak flows from the SCR mitigation project. As described in more detail elsewhere, the reach near Flume 6 was identified as most like the SCR design watershed for hydrologic analysis, with its similar watershed area and elevation. However, the reach near Flume 6 at Walnut Gulch has important physical differences from the SCR mitigation project site. Specifically, Walnut Gulch near Flume 6 flows through a narrower valley with more physical constraints that limit channel migration and sinuosity more than the unconstrained physical conditions at Sonoita Creek. The straight reach of channel downstream of Flume 6 is coincident with a geological fault line and is confined by geologic controls, and therefore should not be used as a reference reach for sinuosity to apply to Sonoita Creek. Nevertheless, there is some braiding between Flume 2 and Flume 6 (**Figure 13**).

Figure 13. Walnut Gulch at Flume 6 and Downstream



The occurrence of braiding along Walnut Gulch is more frequent where there is sufficient width of valley floor to accommodate multiple channels. This occurs to some degree downstream of Flume 6, but more significantly downstream of Flume 2, where relatively less confined reaches of Walnut Gulch are more physically similar to the conditions at Sonoita Creek (despite having a larger watershed area) than the reach near Flume 6. When analyzing channel form, the physical/geomorphological conditions in the reach from Flume 2 downstream to Flume 1 better represent Sonoita Creek than upstream at Flume 6, and are thus more representative of the channel form that is expected for the Sonoita Creek project area.

Channel braiding occurs in many ephemeral drainages in the region, and its appearance in a specific reach is more dependent upon sediment transport mechanics and physical conditions, such as constrained banks versus unconstrained banks, rather than contributing watershed area. A search in Google Earth reveals that many ephemeral streams near Sonoita Creek do exhibit channel braiding, including Sonoita Creek itself, its tributary Big Casa Blanca Canyon, Walnut Gulch and some of its tributaries, and many other ephemeral drainages in the region.

The EPA (2017) indicates that they reviewed Google Earth imagery of Sonoita Creek and determined from the aerial photographs that there is infrequent floodplain access by flows within the Site 6 and Site 8 reference reaches. The EPA suggests that, based on this review of the Google Earth imagery, the SCR mitigation project flood frequency modeling significantly overestimates the frequency of overbank flood events.

In response, we note that Google Earth images of Sonoita Creek and its floodplain are available for a relatively limited period (1992 until present). The individual snapshots do not demonstrably disprove floodplain access by flows at the reference reaches, nor can it be reasonably expected that large events are well represented in images from a relatively short period of record. There is no expectation that within a specific twenty-year period, for example, an event with a twenty-year recurrence interval must occur. The geomorphologist hired by EPA noted frequent floodplain access in the southern reaches of Sonoita Creek (not proposed for restoration) including Site 8 (Kondolf and Ashby 2015). Furthermore, evidence of floodplain access (high-water marks, detritus, etc.) at Sonoita Creek has been observed during site visits. Finally, hydraulic analyses demonstrate that peak flows associated with relatively small, frequent storms, such as the 2-year and 5-year storms, access the floodplain. It is not obvious that these flow events would produce evidence that would be visible in aerial photography, and even if such evidence was produced by a flow event, it is not clear that such evidence would persist long enough to be captured in aerial photographs taken after an overbank flow event.

2.6. Proposed Meander Belt Geometry

The EPA (2017) argues that the proposed meander geometry at SCR does not mimic the reference reaches at Sonoita Creek or Walnut Gulch, and that the proposed channels have a regular or overly symmetrical meander pattern, which does not resemble a complex, erratic pattern typical of natural channels. In addition, while acknowledging that the channel is expected and allowed to self-adjust over time, as described in the HMMP, the EPA (2017) implies that such changes are not sustainable and that the occurrence of natural channel morphology should limit the amount of mitigation credit awarded for channel reestablishment.

Natural channels, completely free of artificial manipulation, can certainly develop complex, irregular channel patterns. However, the level of complexity observed for natural streamforms is also heavily influenced by site heterogeneity. Soil and vegetation heterogeneity, in particular, result in some areas that are more resistant to erosion and other areas that are less resistant. These heterogenous site conditions coupled with the wide spatial and temporal variability of rainfall, flashy flow conditions, high infiltration and the pulsing nature of ephemeral flow and its sediment redistributions can lead to very high levels of channel complexity including braiding and deformed channel patterns. During channel design, significant efforts were made to identify a planform layout with asymmetric and natural-appearing form. Certainly, the proposed channels will be constructed with significantly greater complexity than the existing channel being backfilled and replaced. However, channel layout was required to consider the stability and safety of permanent infrastructure located in the valley. The chosen layout minimizes gas pipeline crossings and the proximity of the channel to both the gas pipeline and the existing road. The proposed channels are configured to liberate the system so that Sonoita Creek will be allowed to develop additional channel complexity dynamically in the future. Flow patterns will respond to heterogenous site conditions that are naturally present but impossible to identify during design, ranging from bedrock outcrops or well-armored areas of channel bank and bed to well-anchored root balls and vegetation.

We also note that it is the current channel configuration that is unsustainable. The current channel configuration includes artificially straightened reaches of channel that are actively incising and reaches where outside stream banks must be artificially armored to protect infrastructure. Natural channel geomorphology featuring the complex deformed channel patterns described by EPA is substantially precluded within the existing Sonoita Creek channel alignment since the resulting erosion and channel migration would impact either the highway or the gas pipeline. Currently, there are numerous hydraulic structures in place to prevent channel migration.

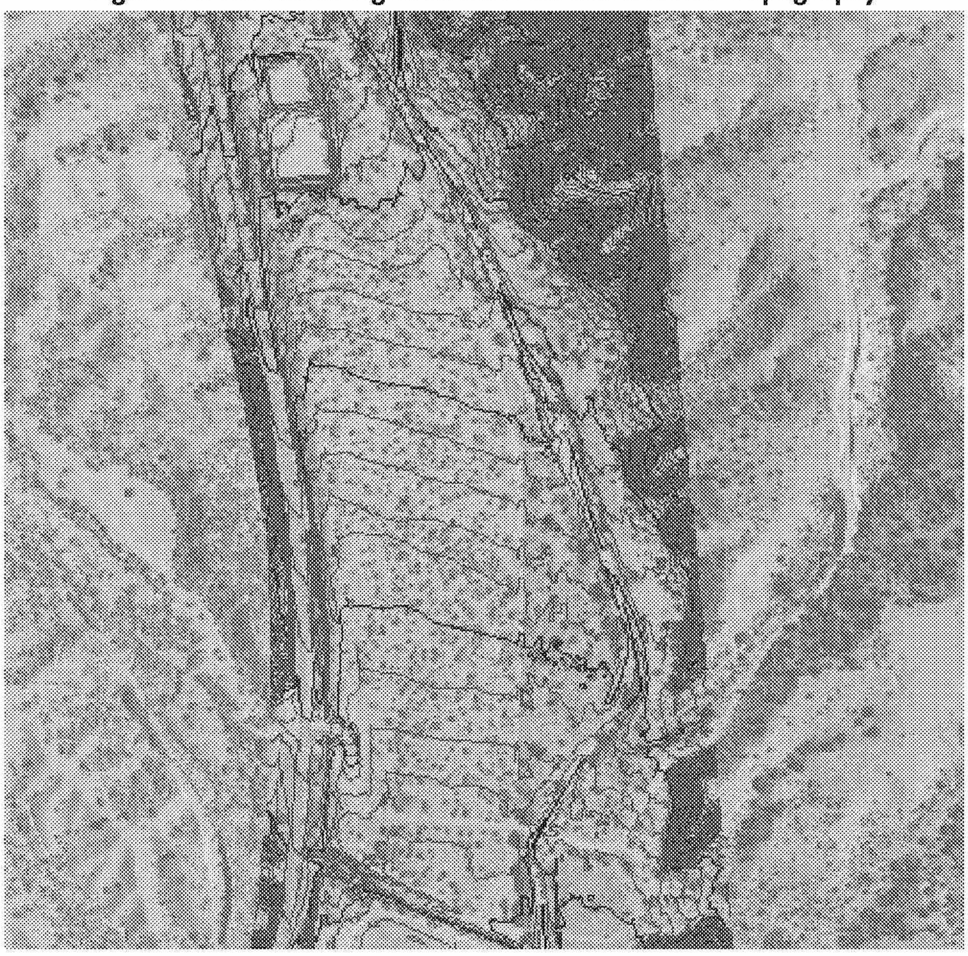
The proposed channel designs already include significant asymmetry and complexity while removing existing constraints that prevent the development of natural channel morphology. The proposed designs will allow natural channel forming during flow events in response to naturally occurring site variability, reestablishing the process by which irregular channel forms occur in natural channels.

2.7. Ecological Justification to Reestablish Sonoita Creek

The EPA compared the 1935 aerial and current day Google Earth aerial photography and argues that because Sonoita Creek was not realigned during that time, and because it has remained stable since that time, that the entire reach upstream of Site 6 could be used as a reference reach. EPA further proposes that because the entire reach could be used as a reference reach, then there is no ecological benefit to realigning the channel.

At RX Ranch, clearly the valley bottom has undergone leveling activities and periodic cultivation. The parallel lines of topography at RX Ranch demonstrate the unnaturally uniform landform in this reach of the valley (**Figure 14**). There is considerable evidence of diversions and manipulation to Sonoita Creek at RX Ranch (**Section 2.3**). Currently, Sonoita Creek at RX Ranch is a straight reach with a single bend located on the east edge of the agricultural field. There is sufficient area within the agricultural field to reestablish Sonoita Creek and create a more sinuous, functional stream.

Figure 14. RX Ranch Agriculture Field and Leveled Topography



The EPA (2017) also argues that the proposed RX Channel was designed with excessively high sinuosity (1.15) to maximize mitigation credits, and implies that the high sinuosity is not sustainable.

In response, we note that the sinuosity measured at Adobe Canyon is slightly higher than the proposed sinuosity of the RX Channel (**Figure 10**). EPA's sinuosity analysis included portions of Walnut Gulch between Flume 6 and Flume 2. However, it is inappropriate to include these portions of Walnut Gulch as reference reaches, as they are physically constrained and confined by local geology/topography and less likely to exhibit a meander pattern that would be expected under the natural unconstrained conditions at Sonoita Creek. Because these reaches do not serve as appropriate reference reaches, they were not analyzed in the HMMP. For instance, there is a straight reach in Walnut Gulch extending upstream and downstream of Flume 6 that is over 3,000-feet long, coincident with a geological fault (shown in Walnut Gulch; **Figure 13**), and highly confined; therefore, it is not an appropriate sinuosity reference to Sonoita Creek.

The EPA (2017) reiterates a prior comment from the Kondolf and Ashby (2015) technical memo (dated July 27, 2015) proposing that the Adobe Canyon-Sonoita Creek confluence is very dynamic with an influx of sediment. EPA later contradicts this statement and writes that this confluence is relatively stable and able to self-adjust. EPA also reiterates that the downstream tie-in with Sonoita Creek would require a certain angle of connection given property constraints and would be challenging to maintain.

Given these contradictions, it is unclear what the EPA's concerns are, or how they believe those concerns should be addressed. Nevertheless, the design of the proposed mitigation does account for the angle of entry and sediment loading in order to ensure a stable stream system. The RX Channel departure for the final HMMP was moved to begin approximately 250 feet downstream from the Adobe Canyon/Sonoita Creek confluence, where the flow and sediment loading is more predictable than in the immediate vicinity of the confluence. Furthermore, the new design reduced the angle of departure and re-entry for the RX Channel so that it has a smooth connection with Sonoita Creek.

The EPA (2017) also states that there is no compelling reason to reestablish the SCR Channel more centrally in the valley, citing many of the same arguments they made in opposition to the proposed RX Channel.

The HMMP extensively details the reasons to reestablish Sonoita Creek to a central position in the valley. The present-day location and layout of Sonoita Creek at SCR on the western edge of the valley is a result of a historic realignment and straightening to accommodate agricultural and infrastructure development, and may well be the remnants or alignment of a 19^{th}-century irrigation ditch (see historical discussion in **Section 2.3**). Sonoita Creek is artificially constrained between the highway and a gas pipeline; this location exacerbates erosion and incision while precluding the development of even minor amounts of channel complexity and an irregular meander pattern found in natural settings as described by the EPA (2017). The Sonoita Creek reaches at RX Ranch and SCR Ranch show clear and extensive evidence of manipulation and include multiple hydraulic structures (concrete channel walls, gabion baskets, car bodies, etc.) designed to armor channel banks and prevent channel migration (**Photos 2 and 3**). These hardened bank structures increase flood velocities, prevent establishment of riparian species and establishment of a functional floodplain, and reduces channel complexity (Florsheim, Mount, and Chin 2008).

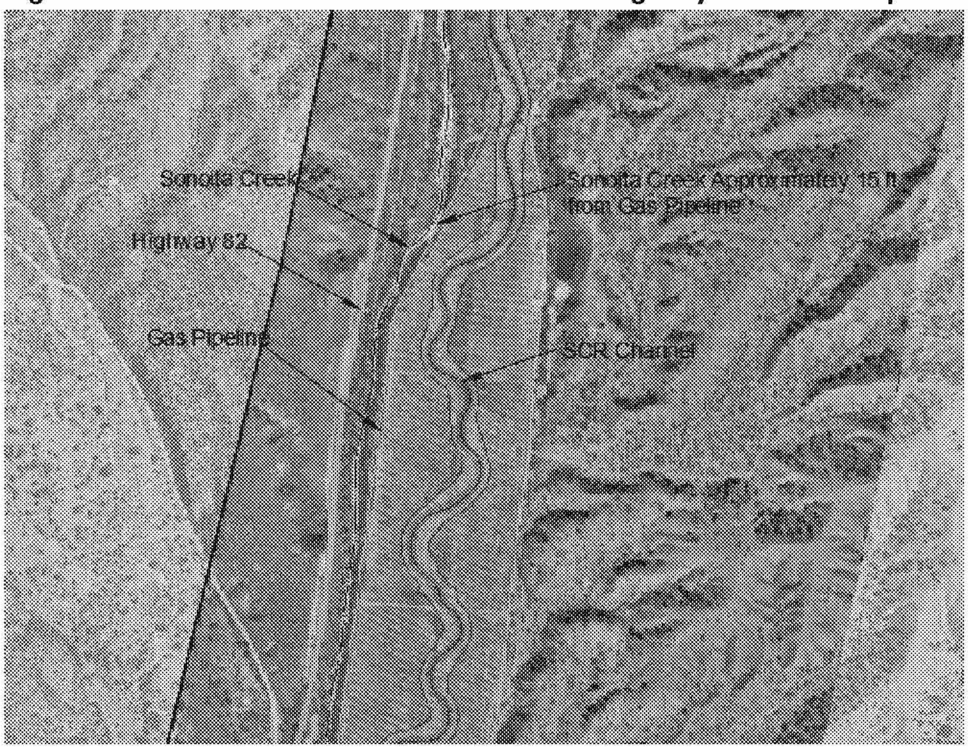
Photo 2. Facing Downstream in Sonoita Creek at SCR with Concrete West Bank

Photo 3. Car Body and other Historic Hydraulic Structures

Finally, the EPA suggests that existing Sonoita Creek at SCR could be rehabilitated by excavating portions of the floodplain along its eastern bank.

This approach is not feasible at SCR because the gas pipeline is parallel to and in close proximity to the current eastern channel bank, in one case as close as about 15 feet (**Figure 15**). Furthermore, rehabilitating only the eastern bank would still leave in place the existing west bank, constrained by the highway and significantly manipulated and degraded by concrete channel walls and gabion baskets. The majority of the artificial armoring, which precludes channel migration or development as well as access to a functional floodplain, is located at the existing west bank at SCR.

Figure 15. Sonoita Creek Constrained Between Highway 82 and Gas Pipeline



Regarding excavation of portions of the floodplain along its eastern bank, for the majority of the existing Sonoita Creek reach located at the SCR Ranch, we note the following:

- There simply is not adequate space to rehabilitate the eastern bank to provide significant ecological benefit;
- The degraded and manipulated west bank will continue to limit functions including: flow access to floodplain, energy dissipation, development of an ecologically functional riparian zone with diverse and/or robust vegetation and wildlife habitat;

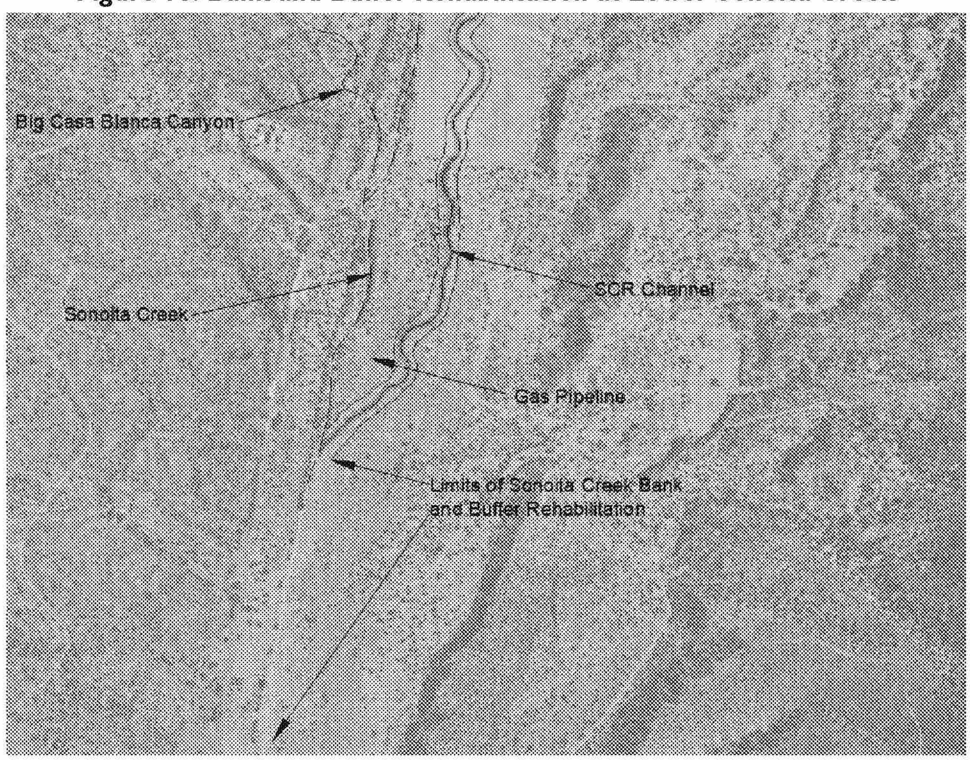
Retaining the current straightened planform necessarily increases channel gradient in the reach, further exacerbating the tendency for high-velocity flow in an incised channel.

2.8. Bank and Buffer Rehabilitation along Lower Sonoita Creek

The EPA (2017) discourages the SCR mitigation project component that includes bank and buffer rehabilitation along the eastern bank of a reach downstream of the major channel rehabilitation reaches. The letter discounts channel bank sloughing and erosion as normal conditions and suggests that Sonoita Creek's channel banks be allowed to erode towards an equilibrium state characterized by a high-functioning floodplain.

This comment is notable in that it directly contradicts the EPA's comment in the immediate preceding paragraph, wherein they recommend rehabilitation along the eastern bank of the existing Sonoita Creek. Bank and buffer rehabilitation along the eastern bank is not practical for Sonoita Creek throughout the majority of SCR because there is not enough space between Sonoita Creek and the gas pipeline. However, bank and buffer rehabilitation is feasible along lower Sonoita Creek (as opposed to backfilling and replacing Sonoita Creek) because there is sufficient space, generally 330 to 350 feet, between lower Sonoita Creek and the gas pipeline (**Figure 16**).

Figure 16. Bank and Buffer Rehabilitation at Lower Sonoita Creek



The final EPA (2017) comment in this section proposes that bank and buffer rehabilitation along the eastern bank of Lower Sonoita Creek will destroy existing high functioning riparian habitat.

At the northern extent of the bank and buffer rehabilitation reach (near the confluence of Big Casa Blanca Canyon and the proposed SCR Channel), Sonoita Creek is incised roughly 6 to 8 feet and has vertical or near vertical banks, effectively segregating Sonoita Creek from the sacaton grassland habitat.

Although the proposed mitigation in this area will impact some acreage of sacaton grassland habitat, we have proposed to salvage sacaton individuals prior to restoration activities and use them to re-populate the agricultural field. If no restoration was to occur in this area, the channel would experience further incision and subsequent bank sloughing that would likewise impact the sacaton. Rehabilitation to the east will reduce the vertical separation between the Sonoita Creek channel bottom and the sacaton grassland, and thus improve floodplain connectivity.

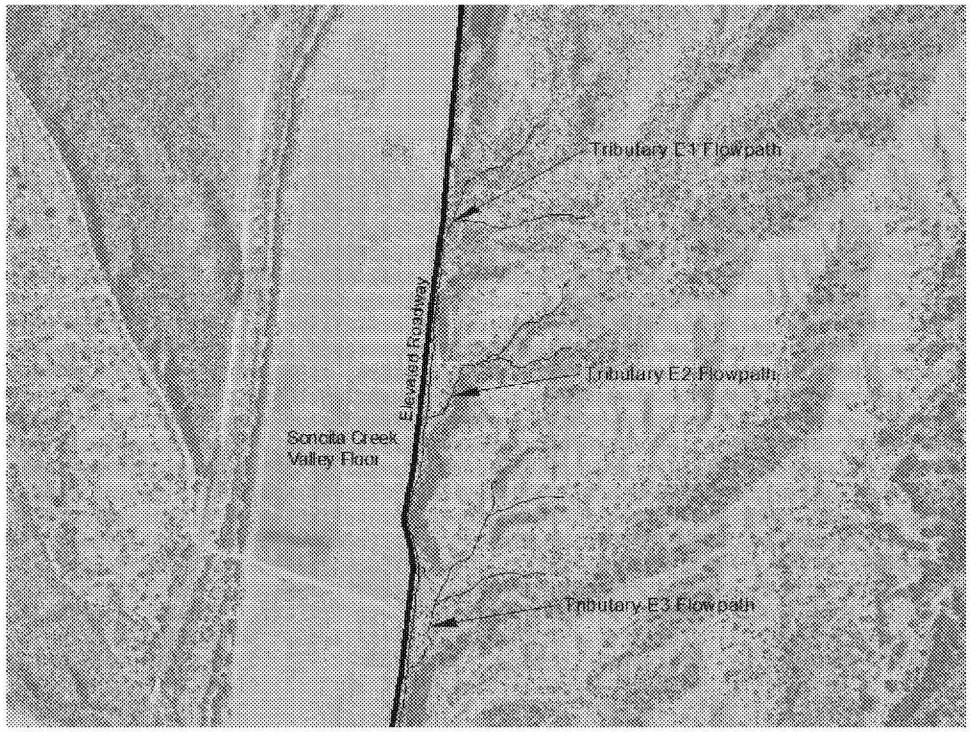
2.9. Assessing the Extension of Three Tributary Channels

The EPA (2017) argues that the three tributary channels that are proposed in the HMMP to be reconnected to the Sonoita Creek mainstem are not naturally characterized by discharges that would discharge to Sonoita Creek, based on a review of the aforementioned 1935 aerial photograph. As described in **Section 2.3**, however, at the time of the 1935 photograph, Sonoita Creek had already been substantially manipulated within the mitigation parcel, leaving it disconnected from the three tributaries.

The EPA (2017) further asserts that the access road on the eastern edge of the agriculture field does not block the flows from the three tributaries. In response, we note that the access road was constructed as a linear fill across the eastern valley edge that is generally 4 to 5 feet higher than the existing terrain to the east. There are no culverts to convey discharge from the eastern tributaries under the road into the Sonoita Creek valley. The access road clearly interrupts flow and sediments from the three tributary channels based upon observations during field investigations (**Figure 17**). Sonoita Creek at SCR is a valley fill that was created as a result of sediments from the tributary watersheds being conveyed into and deposited on the valley floor. The HMMP proposal to reconnect the three eastern tributaries to the SCR Channel will reestablish natural continuity for stormwater hydrology and sediment transport into the Sonoita Creek valley. Furthermore, reestablishment of even small ephemeral drainages such as these will result in a more diverse and natural ecological condition. Therefore, reconnecting the three tributaries will provide substantial ecological benefit for the eastern side of the valley in that area.

The EPA (2017) finally states that there is not sufficient stream power to form a permanent bed and bank channel for the three tributaries. A defined bed is already observed where the roadway interrupts natural flow and diverts stormwater south along the road fill, and there are defined beds for each tributary upstream of the area where they currently terminate. It is speculative to suggest that the channel bed and bank features of the three reestablished connections to Sonoita Creek will recede over the long-term. Even if they do, eliminating the elevated roadway will reestablish the natural drainage pattern for stormwater and sediment to enter the Sonoita Creek valley with associated ecological benefits.

Figure 17. Effect of Elevated Roadway on Tributary Flowpaths



2.10. Preservation of Existing Wildlife Migration Corridors

The EPA (2017) takes issue with the HMMP for its emphasis on the value of the Sonoita Creek Ranch mitigation parcel as a key component of an identified wildlife linkage between the Canelo Hills and the Santa Rita Mountains, asserting that protection of this parcel would not mitigate for the "*significant fragmentation*" of six wildlife linkages at the Project site. The EPA (2017) expresses incredulity at the "*attempt [in the HMMP] to denigrate the significance of the wildlife migration corridors at the mine project site simply by describing these lands as* wildland blocks," *although the FEIS itself notes that "the Santa Rita Mountains [including the Project] represent a fairly large, intact* ***block*** [emphasis added] *of montane habitat...*"

The impacts to the modeled wildlife corridors at the Project site are described in Table 129 of the FEIS, which identifies permanent impacts to only three wildlife corridors, totaling 1,656 acres (which includes impacts from the Arizona National Scenic Trail; a fourth modeled corridor will experience a 1-acre impact due to construction of the Arizona National Scenic Trail). This area represents only approximately 0.7 percent of the entirety of these three wildlife corridors.

In addition, there is no evidence presented, either by the EPA (2017) or in the FEIS, that the effectiveness of the wildlife corridors will be significantly impacted by the Project. For example, WestLand (2012) modeled a movement corridor for jaguars between the northern Santa Rita Mountains (which includes the Project area) and the Whetstone Mountains, using the same GIS modeling methodology as Beier, et al (2008) that combines expert opinion and available scientific literature. The model was then rerun with the Rosemont Project in place and, although the corridor showed an impact from the Project, there remained a functioning modeled corridor for jaguar. As such, the impacts to the wildlife corridors resulting from the Rosemont Project, as described by the EPA (2017), are considerably overstated.

2.11. Groundwater Impacts to the Cienega Creek Groundwater Basin

Continuing the theme of previous comments, the EPA (2017) indicates that the groundwater recharge improvements to be realized by implementation of the proposed Sonoita Creek restoration project would not directly offset modeled groundwater reductions resulting from the Project. However, Rosemont is not required to mitigate for the modeled potential groundwater impacts from the Rosemont Project (as described in comments provided under separate cover). Furthermore, as has been already been noted, the 2008 Mitigation Rule contemplates mitigation measures that may occur in a separate watershed from the aquatic resource impacts. The Sonoita Creek restoration project will result in improved groundwater recharge through a significant, restored stream system, in an adjacent watershed to the Rosemont Project.

2.12. Sediment Supply Reach Assessment

The EPA (2017) argues that the mean annual sediment load must match upstream supply, and without this analysis it is not possible to predict how the reestablished channels at the SCR mitigation parcel will behave.

During design of the SCR mitigation project, an incipient motion analysis was conducted that confirmed that the design channels were capable of transporting bed materials through the system. Additional analyses that were completed using Brownlie sediment transport capacity relationship show a reasonable balance of sediment transport capacity between supply and design reaches. However, caution should be exercised when comparing sediment transport capacity for supply and design reaches for ephemeral systems such as Sonoita Creek. The analytical approach of matching supply and design reach transport capacity assumes equilibrium concepts which are less suitable for arid ephemeral streams with episodic pulses of stormwater and sediment. It is this natural imbalance of sediment supply and sediment transport capacity that significantly contribute to the dynamic nature of functional ephemeral streams and the diversity in channel form and habitat.

The channel reestablishment proposed for Sonoita Creek liberates this stream by shifting the channel alignment away from infrastructure such as the highway and gas pipeline, and significantly increases the mechanisms for the channel to adjust, namely by adjusting channel width, depth and planform. The reestablished Sonoita Creek will become more resilient to changes in sediment supply resulting from both anthropogenic factors such as land use changes and also by natural factors such as forest fires and shifting vegetation patterns resulting from climate change. Currently, Sonoita Creek at SCR is artificially constrained in an otherwise unconstrained environment (alluvial valley) and its primary mechanism for adjustment is to change channel depth. Changes to channel width and planform have been arrested with car bodies, gabion baskets and concrete channel walls, and significant planform changes would impact either the highway or the gas pipeline. The HMMP presents a channel reestablishment plan for Sonoita Creek that will continue to provide sediment transport under the current climatic conditions, and is far more capable of adjusting to future changes to sediment supply and sediment transport capacity than the existing, altered configuration.

2.13. Enhancement Credits for Fencing Ephemeral Streams

In this section, the EPA (2017) repeats their assertion that enhancement credits should not be provided to the smaller ephemeral washes and associated buffers as a result of fencing the Sonoita Creek Ranch mitigation parcel with wildlife-friendly and wildlife-barrier fencing. They emphasize this point by noting that wildlife-friendly fencing is not as conducive to wildlife movement as no fencing at all, which is an obvious observation that has little to do with Rosemont's proposed mitigation package.

As noted in the HMMP, the existing fencing and cross-fencing at the mitigation parcel is standard barbed wire. Rosemont proposes to replace this with wildlife-friendly fencing around the majority of the parcel, and wildlife-barrier fencing along SR 82, thereby *enhancing* the movement of wildlife along the ephemeral wash travel corridors through the site. The proposed mitigation will therefore have a net benefit for this well-understood aquatic resource function.

2.14. Assessing Soil Repositories

The EPA (2017) reiterates comments from Kondolf and Ashby (2015) regarding the likelihood of erosion at the Soil Repositories. The EPA (2017) further states that differential settlement may change drainage of the Soil Repositories.

The Soil Repositories have relatively low average gradients that range from 1.2 percent to 6.7 percent, whereas the undisturbed slopes have average gradients ranging from 20 percent to 50 percent. Steeper and longer slopes have higher erosion rates than flatter and shorter slopes. Many of the steep fill slopes (generally 10 percent to 40 percent) for Highway 82, which are disturbed fill soils comparable to those proposed at the Soil Repositories, are much steeper than the proposed slopes at the Soil Repositories. Yet they are largely stable and vegetated.

The proposed Soil Repositories will be constructed in horizontal lifts to minimize differential settlement. They will also be constructed using geomorphic landform techniques, with significant topographic complexity. The topographic complexity results from construction of many small undulations creating a network of small ridges and swales that will convey stormwater off the upland slopes to the valley floor. Immediately following fill placement, the Soil Repositories will be decompacted (cross-contour ripping), seeded to native upland species, and mulched. The Soil Repositories have modest hillslope gradients and will be constructed with best technology currently available. In general, landforms built using these techniques illustrate that they are stable after construction, do not exhibit differential settlement, and can be successfully revegetated with a diversity of native species.

2.15. Enhancement of Two Ponds at SCR

The EPA (2017) asserts that enhancement credit is not warranted for any modifications to the two ponds at the Sonoita Creek Ranch mitigation parcel to support the protection of sensitive species. The EPA (2017) provides the following reasons (in *italics*), and we respond to each in turn (in normal text):

- *Enhancement credit requested to support recovery efforts of listed endangered species does not offset the physical loss of headwater streams at the mine site.*

  Rosemont recognizes that the proposed enhancement of the two ponds is out-of-kind with impacts to the headwater washes at the Project site. However, both the 2008 Mitigation Rule and the SPD guidance allow for out-of-kind mitigation, and even encourage this type of mitigation (through beneficial mitigation ratio adjustments) where the mitigation elements represent "rare" and "regionally significant" habitat, which the perennial ponds assuredly do. As noted in the HMMP, these ponds are comprised of approximately six acres of open water habitat and associated wetlands and riparian area. They enhance the function of the mitigation parcel as a wildlife corridor, and provide an opportunity to support the protection of federally listed aquatic species. As such, the two ponds represent an important out-of-kind mitigation opportunity.

- *Rosemont has failed to demonstrate there is sufficient water from Monkey Spring to support any enhancement or establishment of wetlands/waters;*

  Monkey Spring flows are addressed in the following section (**Section 2.16**).

- *Performance standards used to determine whether the compensatory mitigation project is achieving its objectives are lacking;*

  As noted in the HMMP, any mitigation measures proposed for the ponds would include the removal of exotic predator species, an enhancement measure in itself. Any additional performance standards will be identified once the final approach for the ponds is determined through coordination with the relevant agencies.

- *The temporal loss of waters could be significant due to a lengthy and risky Arizona Department of Water Resources (ADWR) approval process.*

  This comment, regarding the potential "temporal loss of waters" resulting from an ADWR process, is addressed in **Section 2.18** of this report.

2.16. Water Source at Monkey Spring

The EPA (2017) expresses concern that the flow from Monkey Spring may not be suitable to sustain the two ponds at the Sonoita Creek Ranch mitigation parcel, going so far as to assert that the current flow level represents "a drastic decline in the amount of available water since 1966." In this section, we document the substantial and persistent flows from Monkey Spring.

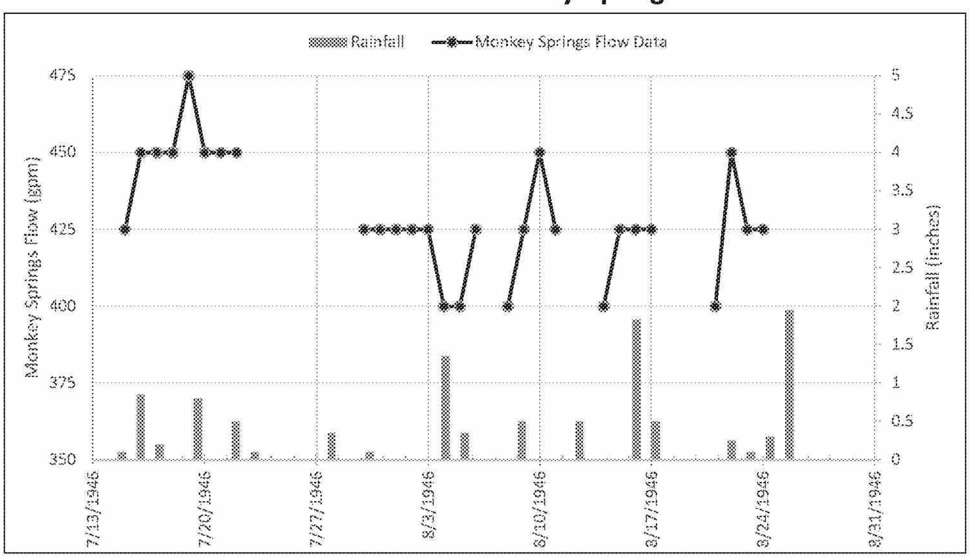
Surface water rights for Monkey Spring are quantified by Certificate of Water Right 33-26063.0001 which represents 785 acre-feet per annum (AFA) of water for irrigation and 657,000 gallons per year (slightly over 2 AFA) for stock watering, for a total of approximately 787 AFA.

The SCR mitigation parcel is entitled to 75 percent of the certificated flows or 75 percent of the actual flows if the total Monkey Spring flow is less than 787 AFA. As part of the agreement with the upstream property owner, Monkey Spring flows are to be directed to SCR 75 percent of the time.

Two depositions in support of the surface water certificate taken in 1987 by Cora Everhart and Stone Collie (Certificate of Water Right 33-26063.0001) state that water from Monkey Spring has been used for irrigation of approximately 150 acres, support of an average of 300 head of cattle, and support of 6 dirt tanks since before June 12, 1919.

For his dissertation, Feth (1947) installed a weir downstream of Monkey Spring from July 15, 1946 through August 24, 1946 and measured flow on 28 days. **Exhibit 1** shows the measurements and rainfall recorded during the same period. Measured flows ranged from 400 to 475 gallons per minute (gpm) (645 to 766 AFA) with an average of 429 gpm (693 AFA).

Exhibit 1. Measured Monkey Spring Flows



(Feth 1947)

A Parshall flume was installed on SCR property in 2015 to measure Monkey Springs flows entering the property, and flow data has been collected since April 30, 2015. Data are collected every 15 minutes; 84,882 data points were collected and analyzed between April 30, 2015 and October 4, 2017.

Exhibit 2 is a frequency histogram[1] of all of the flow data collected during this period. The data are divided into four groups:

1. **Bad Data**: flows measured in this group were much higher than the flow meter could reasonably measure and were thought to be the result of trash and twigs temporarily caught in the meter. This represents approximately 0.2 percent of the data collected.
2. **Possible Cottonwood Spring Flows**: Cottonwood Spring is also controlled by the upstream property owner. Cottonwood Spring is hydraulically connected to the canal from Monkey Spring to SCR, but this connection is rarely open. The upstream property owner will sometimes open the connection to provide irrigation to trees on the upstream property, and the overflow goes to the canal. Again, this rarely occurs, but when it does it adds to the Monkey Spring Flow. This represents less than 0.002 percent of the data collected.
3. **Low Flow**: When the upstream property shuts off Monkey Spring flow to SCR, there is usually still some flow in the SCR canal. Sometimes, instead of shutting the flow off entirely, the upstream property will take a part of the flow. This complicates the analysis of flows from Monkey Spring. For the following analysis, it was assumed that the lowest 25 percent of data points (0 to approximately 270 gpm) represented use by the upstream property
4. **Data Analyzed**: The remaining data were used to estimate the average flow from Monkey spring to the SCR Parshall flume. The estimate will be low for two reasons:
    a. Some of the data points are still associated with partial use by the upstream property.
    b. Data at the Parshall flume do not account for losses due to evaporation and seepage between Monkey Spring and the Parshall flume.

[1] A frequency histogram is a statistical tool used to show the frequency of values within predetermined class intervals. The frequency represents the number of measurements with resulting values within a class interval. It is standard practice to label the *y*-axis frequency (Ott and Longnecker 2010).

Exhibit 2. Frequency Histogram of SCR Parshall Flume Flow Measurements April 30, 2015 through October 4, 2017

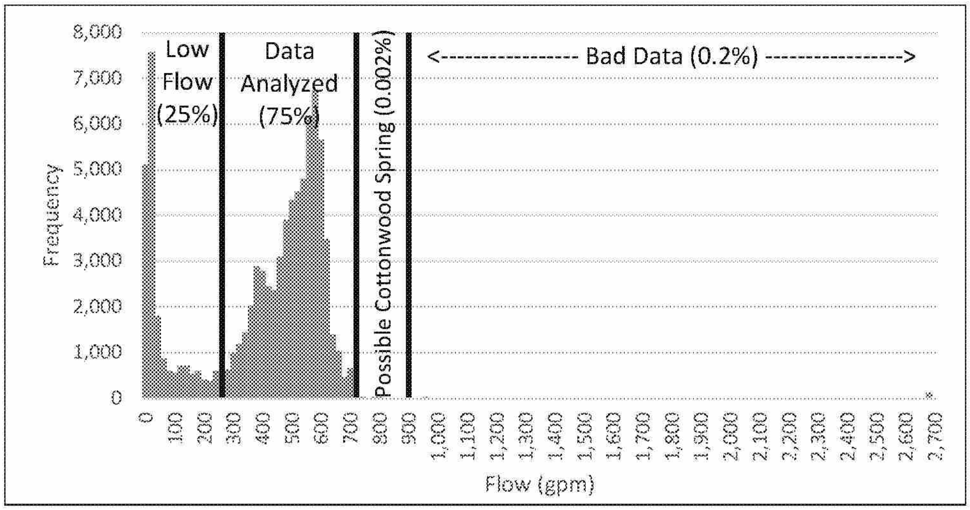


Exhibit 3 is a frequency distribution of the data used in the analysis of the Monkey Spring flow. The data range from approximately 270 gpm (436 AFA) to approximately 720 gpm (1,161 AFA), and represent approximately 75 percent of the data collected (63,200 data points). The average flow is approximately 509 gpm or 820 AFA.

Exhibit 3. Frequency Histogram of SCR Parshall Flume Flow Measurements Used in Monkey Spring Flow Analysis

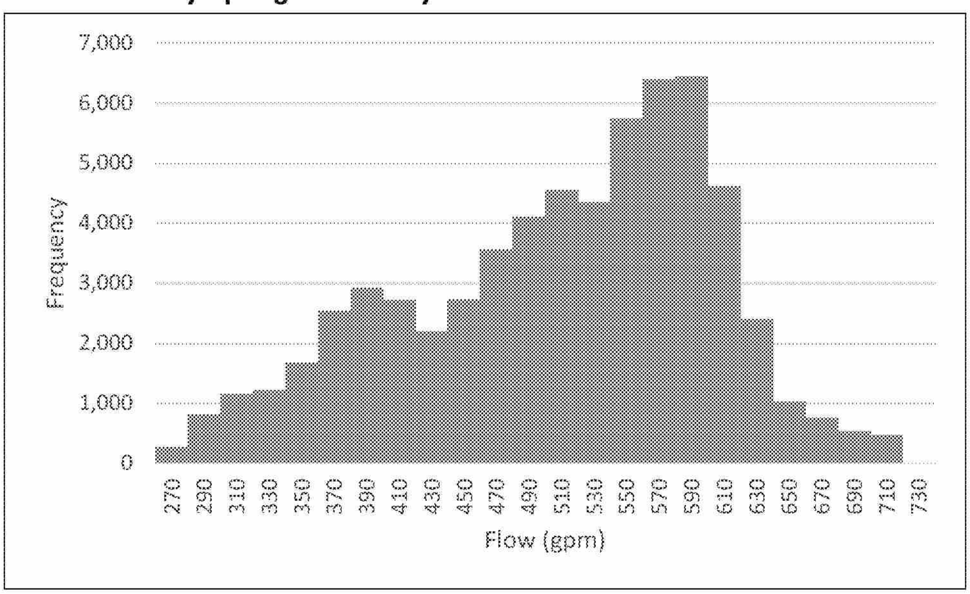
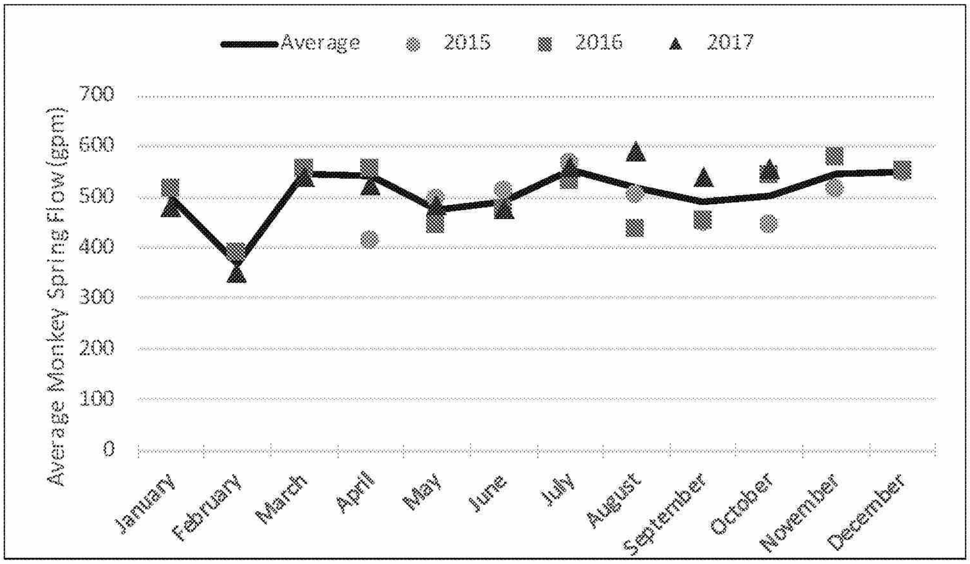


Exhibit 4 shows the monthly average measured flow for the data presented in **Exhibit 3**. The markers represent the single-month averages for 2015, 2016 and 2017; the line represents the average flow for all data associated with each month. There is some variation in the measured flow through the year ($p < 0.04$), but no significant variation between years ($p > 0.57$). The largest variation occurs in February,

with an approximately 27-percent reduction from the average flow of 509 gpm. The variation for the remaining months varies from plus or minus 1 percent to 8 percent of 509 gpm. The variation among years varies from approximately 0.4 percent to approximately 0.8 percent of 509 gpm.

Exhibit 4. Monthly Average Measured Flow (April 2015 through October 2017)



As demonstrated here, the flow from Monkey Spring reporting to the SCR mitigation parcel is consistent with flows measured over 70 years ago (i.e., average flow of 429 gpm historically and average flow of 509 gpm recently measured), and there is no indication that flows will be reduced in the future. As such, the Monkey Spring flows represent a reliable and significant element of the overall mitigation proposal at SCR.

2.17. Enhancement Credit for the SCR Ponds

The EPA (2017) revisits a number of previous comments related to the SCR ponds, all of which have been addressed elsewhere in this document. Specifically, the EPA (2017) states that there are no accurate flow measurements for Monkey Spring flows (**Section 2.16**), that the proposed measures for the ponds do not warrant enhancement credit (**Section 2.15**), that the proposed enhancement of the ponds does not compensate for impacts to headwater washes at the Rosemont Project site (**Section 2.15**), and that the described performance standards are inappropriate (**Section 2.15**).

2.18. Temporal Credit

The HMMP contemplates a beneficial use of the SCR water within the same land base as the current Certificate of Water Right. No severance and transfer of the place of beneficial use is necessary. To the extent that the HMMP dedicated uses may be considered a change in beneficial use, Arizona law provides a mechanism for such change. A.R.S. § 45-156(B) provides that a change in use may be accomplished by determination of the ADWR. A request for change in beneficial use does not require the pre-consent of any third party, and is not an elongated process. It may be undertaken simultaneously with the restoration work contemplated in the HMMP. Regardless, the water remains onsite and available for discharge during the process.

3. ONSITE STOCK TANK REMOVAL

The EPA (2017) provides the following comment regarding the HMMP: "*The HMMP describes mitigation for losses of stormwater flows for impacts to 28.4 acres of waters downstream from the mine site that involves removing three impoundments within the project area and returning those flows to McCleary Canyon, and to downstream reaches of Barrel and Davidson canyons.*" The reference to 28.4 acres of downstream waters applies to a previous (2014) iteration of the HMMP, and that concept has not been carried forward into the current HMMP. Instead, potential downstream losses are identified as flow reductions, as described in the FEIS.

The EPA (2017) also indicates that: "*Rosemont contracted with Tetra Tech to revise stormwater modeling in the FEIS because Rosemont believes those models overestimate the reductions in stormwater flows due to mine construction.*" This statement is incorrect. Tetra Tech did not "revise the stormwater modeling" or methodology but instead, provided an additional analysis using the same methodology used in the FEIS to estimate what quantity of surface stormwater flows reported to stock ponds. The runoff volume reporting to existing stock ponds was never taken into account in the original pre-mining runoff-volume estimate used in the FEIS (Tetra Tech 2010). The additional analysis was prepared so that a comparative analysis could be made between the original pre-mining and post-mining runoff estimates without changing the methodology in the FEIS.

The analysis performed by Tetra Tech (Tetra Tech 2017), and described in the HMMP (Section 2.1.4.2), demonstrated that using the same methodology as in the FEIS, the total runoff volume reporting to onsite stock ponds was significant. Approximately 20 percent (20% = 279 AFA/1404 AFA) of the originally calculated pre-mining runoff volume (i.e., 1,404 acre-feet annually [AFA]) was actually reporting to onsite stock ponds. In light of the new analysis, the HMMP went on to mention that if the original pre-mining and post-mining runoff analysis would have taken into account the runoff volumes reporting to stock ponds, the actual reduction in stormwater flows due to mining operations would have been considerably less. The revised calculations showed that, when considering runoff volumes reporting to stock ponds, the total estimated reduction in surface water flows reporting downstream was only 2 AFA, as opposed to the original estimate of 242 AFA. For additional clarity, these revised calculations for pre-mining and post-mining flows are provided in **Tables 2 and 3**, respectively. The 2 AFA is derived by subtracting the post-mining flow of 1,123 AFA from the pre-mining flow of 1,125 AFA, when considering the presence of stock ponds.

Table 2. Revised Pre-Mining Estimates Considering Runoff Volumes Reporting to Stock Ponds Using Original Methodology

	Watershed Area (sq. mi.)	Runoff Volume (AFA)	
Original pre-mining runoff estimate in FEIS, not including stock ponds	14.0	1,404	(1)
Estimated runoff reporting to onsite stock ponds (located within mine disturbance footprint) from Tetra Tech (2017)	2.1	240	(2)
Estimated runoff reporting to onsite stock ponds (located outside disturbance footprint) from Tetra Tech (Tetra Tech 2017)	0.3	39	(3)
Updated Pre-mining runoff estimate including stock ponds	**11.6**	**1,125**	(1) - (2+3)

Note: Values rounded

Table 3. Revised Post-Mining Estimates Considering Runoff Volumes Reporting to Stock Ponds Using Original Methodology

	Watershed Area (sq. mi.)	Runoff Volume (AFA)	
Original Post-mining runoff estimate in FEIS, not including stock ponds	11.3	1,162	(1)
Estimated runoff reporting to onsite stock ponds located within mine disturbance footprint. These watershed areas reporting to stock ponds are eliminated by mining facilities and thus subtraction of watershed areas have already been accounted for in the reduced post-mining watershed area calculation.	0	0	(2)
Estimated runoff reporting to onsite stock ponds (located outside of disturbance footprint) from Tetra Tech (Tetra Tech 2017)	0.3	39	(3)
Updated Post-mining runoff estimate, including stock ponds	**11.0**	**1,123**	(1) - (2+3)

Note: Values rounded

Acknowledging this previously unaccounted for available surface-water volume reporting to stock ponds, the HMMP then proceeded to discuss how the release of water impounded behind stock ponds can be used as a viable option for mitigation. With a revised projected stormwater reduction of 2 AFA, the HMMP discussed that this reduction in surface-water flow can be readily offset by breeching three of the stock ponds not impacted by mining activities (i.e., Gunsight Pass Tank, McCleary Canyon Stock Tank, and Rosemont Crest Tank). This would allow previously impounded water to be released downstream, thus providing mitigation for the 2 AFA.

The EPA (2017) has expressed concern relating to the revised pre-mining and post-mining estimates and has questioned the validity of the methodology: "*The estimates of average-annual runoff rely on an inappropriate model/regression equation. The regression equation can only apply to the limits of the data. A continuous simulation model with daily time steps would be more appropriate. A regional model such as a SWAT-based model that is localized with smaller resolution grids is an example of such an approach.*" This observation is flawed, however, because it is not the resolution or time step of the model that is of primary importance, but rather the relative comparison between the modeling results (i.e., modeled pre-mining flows vs. modeled post-mining flows). The EPA's assertion, that a continuous simulation model with daily time steps is more appropriate, is speculative. Research has shown that continuous and distributed simulation models (such as the EPA's proposed SWAT model) may not always result in superior performance over lumped and empirical type models (Reed et al. 2004). This is often the case for desert (semi-arid) watersheds, such as in this instance. For the Rosemont Project, an empirically derived model, such as the one used in the FEIS, was deemed appropriate. The empirical model used in the FEIS was developed primarily to assess the relative comparison of pre-mining vs. post-mining average-annual runoff volumes and not the actual runoff volumes. In addition, if a detailed model were implemented, as requested by the EPA, the analysis would no longer be based upon an "average-annual" estimate, but rather upon a simulated snapshot of current watershed runoff conditions of the current model year. The original intent of the runoff analysis was to estimate relative comparisons between pre-mining and post-mining flows on an "average-annual" basis, which is what has been done. The 401 Certification issued by ADEQ requires Rosemont to conduct more detailed hydrologic modeling on an annual basis to determine project impacts on downstream flows and implement mitigation measures. This model is currently being constructed and calibrated using recently established high resolution rainfall data and streamgage data at the site.

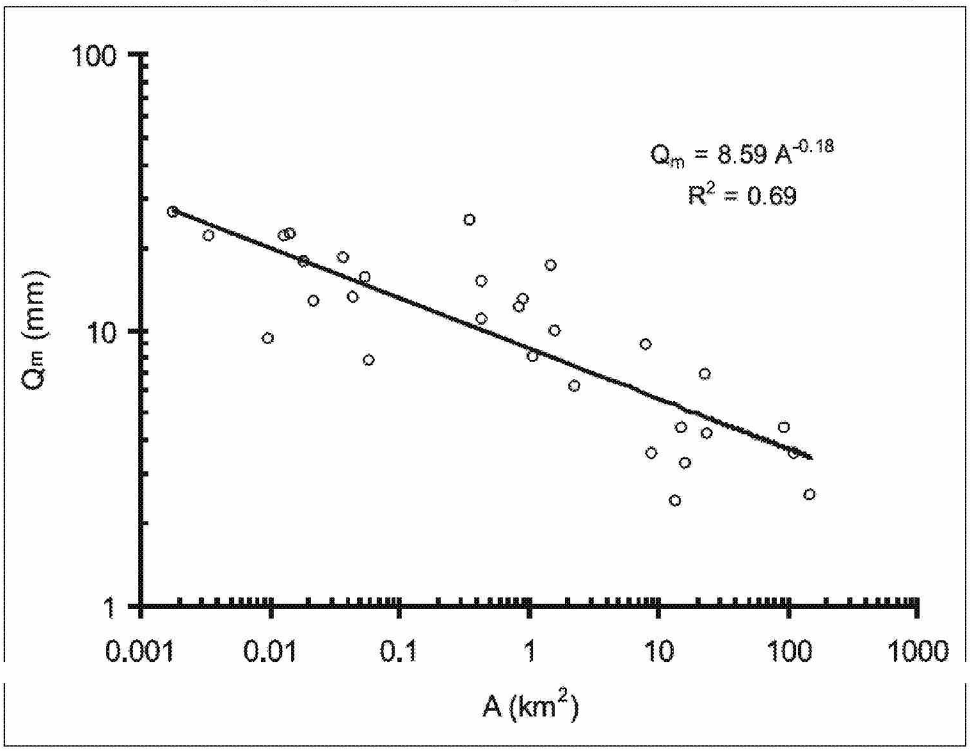
The EPA (2017) also comments that the runoff regression methodology used does not consider stock pond capacities, and that if pond capacities are taken into account, the runoff regression methodology will demonstrate that the ponds do not have sufficient capacity. The EPA is correct, in that the stock ponds will not have sufficient capacity to retain runoff volumes estimated by the runoff regression methodology. However, it has recently become apparent, based on nine years of continuously recorded streamgage data at the USGS gaging station located immediately downstream of the Rosemont watershed in Barrel Canyon at SR 83 (USGS 09484580 BARREL CANYON NEAR SONOITA, AZ; referred to herein after as the USGS SR 83 streamgage), that the runoff regression methodology originally employed to estimate average-annual runoff is, in fact, extremely conservative, and significantly overestimates runoff volumes emanating from the Project watershed area. That is, recent runoff data, recorded for the past 9 years (from 2009 through December 31, 2017) at the USGS SR 83 streamgage indicates that the average-annual runoff (on a calendar-year basis) is approximately 124.4 AFA. The minimum value recorded was 34.0 AFA (in 2009), and the maximum value recorded was 260.8 AFA (in 2017; includes provisional data). Thus, the regression methodology significantly overestimates actual annual runoff measurements by more than 11 times (11.3 = 1,404 AFA/124.4 AFA). Given the lack of data from this streamgage at the time the original regression equations were developed in 2010, it was necessary to use data from regional USGS-gaged watersheds. As such, the original regression equation analyses significantly overestimated the amount of flow discharging from the Rosemont watershed.

Despite its overestimation, the runoff regression methodology was carried forward in the Tetra Tech (2017) study so that a consistent methodology was maintained. Although the regression methodology overestimated actual runoff volumes, it is postulated that the comparative analysis performed in Tetra Tech (2017) and in the HMMP to estimate project impacts on stormwater flows is still valid.

Nevertheless, it is demonstrated here that, through the use of the more recent runoff data measured at the USGS SR 83 streamgage, the stock ponds have sufficient capacity to retain average-annual flows, and thus can provide mitigation for the estimated 2 AFA of stormwater flow reduction.

However, before such a demonstration is presented, the following additional information is provided regarding the actual runoff that discharges from the Rosemont watershed. In 2008, Stone et al. (2008) collected and analyzed average-annual runoff volumes that were collected from streamgages on the Walnut Gulch and the Santa Rita Experimental watersheds, both located in southern Arizona and in close proximity to the Rosemont watershed. Using the runoff data, which was collected as early as the 1950s, Stone et al. (2008) developed a regression equation to estimate average-annual runoff based on watershed area. This equation is presented in **Exhibit 5** and compares average-annual stormwater runoff per unit area to the size of the catchment area.

Exhibit 5. Average-Annual Runoff Regression from Stone et al. (2008)



Note: The equation depicted in the preceding figure for average-annual runoff per unit area is: $Q_m = 8.59A^{-0.18}$, where the units of runoff (Q_m) are average depth in millimeters per unit area (square kilometer), and the units of area (A) are in square kilometers.

In English units, the equation in **Exhibit 5** is: $Q_{AFA} = 15.20A^{-0.18}$, where Q_{AFA} is the annual runoff in acre-feet per unit area (square mile), and A is the watershed area in square miles. Assuming A = 14 square miles (the total size of the Rosemont watershed at the USGS SR 83 streamgage, not subtracting areas reporting to stock ponds) the resulting value of AFA per square mile, in English units, is: Q_{AFA}

= $15.20(14)^{-0.18}$ = 9.45 AFA per square mile. Thus, 132.3 AFA (132.3 = 9.45 x 14) is predicted to emanate from the 14-square-mile Rosemont watershed. This estimate is very close to the current USGS SR 83 streamgage 9-year average of 124.4 AFA. In runoff per unit area, 124.4 AFA translates to 8.9 AFA per sq. mi (8.9 = 124.4/14). The runoff value estimated using the equation by Stone et al. (2008) is within 6 percent (6% = [132.2-124.4]/124.4) of the actual measured average-annual runoff (at the USGS SR 83 streamgage). This Walnut Gulch relationship for average-annual runoff supports the conclusion that the average-annual runoff at the USGS SR 83 streamgage is about 11 times less than what was previously estimated in the FEIS using the original regression methodology. At a larger watershed scale, the trend toward a decrease of runoff, as shown in **Exhibit 5**, has been demonstrated to be a combination of both transmission losses and the limited areal extent of thunderstorm runoff.

Furthermore, in the late 1960's to mid-1970's a USGS streamgage (Streamgage No. 09484590, Davidson Canyon Wash near Vail, Arizona) was in place along the downstream extent of Davidson Canyon. Runoff data was collected by the USGS at that streamgage for a period of 6 years (1969 through 1974). The data collected for these 6 years are provided in **Table 4**.

Table 4. Runoff at the USGS Streamgage No. 09484590, Davidson Canyon Wash near Vail, Arizona

Calendar Year	Runoff (AFA)
1969	286.9
1970	1043.2
1971	847.6
1972	239.8
1973	0.7
1974	753.4
Average	**528.6**

The size of the Davidson Canyon Watershed (not subtracting areas reporting to stock ponds) at the location of the referenced streamgage is 50.5 square miles, as determined by the USGS. Therefore, at this location the runoff (AFA) per square mile emanating from Davidson Canyon during the time period of 1969 through 1974 was equal to 10.47 AFA per square mile (10.47 = 528.6/50.5). Applying this runoff supply rate to the Rosemont 14 square mile watershed yields about 146.6 AFA (146.6 = 10.47 x 14). The runoff value estimated using the Davidson Canyon gage data is within about 18 percent (18% = [146.6-124.4]/124.4) of the actual measured average-annual runoff at the USGS SR 83 streamgage.

Given the high variability of rainfall-runoff relationships in semi-arid regions such as southern Arizona, the 9-year average-annual runoff measured at the USGS SR 83 streamgage is in reasonable agreement with other regional gage data. Accordingly, it is argued that the runoff data gathered at the USGS SR 83 streamgage since 2009 provides a good representation of the annual-average runoff emanating from the Rosemont watershed.

Now that it has been demonstrated that the average-annual runoff is considerably less than originally estimated, the original EPA comment regarding stock pond capacities can be addressed. Through a simple, yet practical, hydrologic runoff analysis, it is demonstrated, that the stock ponds will have sufficient capacity to retain runoff on an average-annual basis. A hydrologic relationship based on a unit area runoff supply rate can be easily developed as discussed in the in the following paragraphs.

Previously, it was shown that the regression equation developed by Stone et al. (2008) reasonably predicts the average-annual runoff emanating from the Rosemont watershed at the USGS SR 83 streamgage. On this basis, it can then be reasonably asserted that annual runoff per unit area emanating from Rosemont watershed subareas, Q_{ARSA}, is proportional to $A^{-0.18}$; mathematically expressed as:

$$Q_{ARSA} \propto ZA^{-0.18} \qquad \textbf{Equation 1}$$

where Z is a coefficient. Considering the existence of stock ponds in the watershed, only 11.6 square miles of the Rosemont watershed actually contributes to runoff at the USGS SR 83 streamgage. This is because runoff from 2.4 square miles of the Rosemont watershed is currently being captured by stock ponds located throughout the watershed. Thus, on this basis, a regression equation for the Rosemont watershed can be determined. Using the 9 calendar years of runoff data at the USGS SR 83 streamgage, the average-annual runoff is 124.4 AFA; so, the runoff per unit area is 10.724 AFA (10.724 = 124.4/11.6). Substituting those values into Equation 1 yields:

$$10.724 = Z(11.6)^{-0.18} \qquad \textbf{Equation 2}$$

Solving for Z in Equation 2 yields 16.67. Therefore, Equation 1 can be rewritten as:

$$Q_{ARSA} = 16.67A^{-0.18} \qquad \textbf{Equation 3}$$

The relationship in Equation 3 can be modified to predict total average-annual runoff (instead of runoff per unit area). Both sides of Equation 3 are multiplied by the area (A), resulting in the following:

$$Q_{ARSA}A = 16.67A^{-0.18}A \qquad \textbf{Equation 4}$$

or,

$$Q_{AFAT} = 16.67A^{0.82} \qquad \textbf{Equation 5}$$

where Q_{AFAT} = the average-annual runoff (in acre-feet) for a sub-watershed in the Rosemont watershed with area A (in square miles).

Thus, Equation 5 can be used to compute average-annual runoff from each of the drainage areas located upstream of, and captured by, existing stock ponds. Using this runoff regression equation, the estimated runoff volumes are calculated and compared to the physical holding capacities of each stock tank (physical holding capacities were estimated from topographic surveys). The results are summarized in **Table 5**.

Although several of the stock tank capacities are exceeded under this analysis, actual exceedances would not be anticipated because runoff-generating storm events are temporally distributed over the monsoon season and do not occur during a single event. Based on observations, the number of runoff generating storm events has roughly averaged about 8 storms per year over the recorded 9-year period of runoff measured at the USGS SR 83 streamgage. Thus, the total estimated runoff volumes can be divided by 8 (or distributed over 8 storm events) for a coarse approximation of the volume of discrete runoff events. **Table 5** shows containment of discrete storm events for all ponds evaluated.

Additionally, considering evaporation, transpiration, and infiltration at each stock pond, the actual holding capacities of all of the stock ponds would likely be higher than the storage capacities listed in **Table 5**.

Table 5. Stock Tank Volume Capacity Analysis Using Recent Runoff Data at USGS Streamgage

Stock Pond Name	Watershed Area Upstream of Pond (acres)	Total Estimated Runoff Volume (AFA)	Stock Tank Capacity (AF)	Stock Tank Excess Capacity (AF)	Estimated Runoff Volume per Storm Event (8 storms per year; AF)	Stock Tank Excess Capacity per Storm Event (AF)
Gunsight Pass Tank	5.1	0.32	0.36	0.04	0.04	0.32
McCleary Canyon Stock Tank	185.3	6.03	3.60	(2.43)	0.75	2.85
Rosemont Crest Tank	20.8	1.00	0.54	(0.46)	0.13	0.41
Upper Stock Tank *	85.4	3.20	2.37	(0.83)	0.4	1.97
Lower Stock Tank 1 *						
Lower Stock Tank 2 *						
Wasp Canyon Stock Tank	1.5	0.12	0.79	0.67	0.02	0.77
Asarco Stock Tank	113.2	4.03	4.72	0.69	0.50	4.22
Wasp Canyon Stock Tank 2	48.7	2.02	4.61	2.59	0.25	4.36
Rosemont Spring Stock Tank	71.3	2.76	1.33	(1.43)	0.35	0.98
Barrel Tank	81.3	3.07	5.22	2.15	0.38	4.84
North Basin Tank	92.2	3.40	10.15	6.75	0.43	9.72
Trail Creek Upper Stock Tank	81.0	3.06	2.23	(0.83)	0.38	1.85
Barrel Canyon East Dam Tank	733.9	18.65	3.94	(14.71)	2.33	1.61
Total	**1519.9**	**47.66**	**39.86**	**(7.80)**	**5.96**	**33.9**

* Upper Stock Tank, Lower Stock Tank 1, and Lower Stock Tank 2 are a series of ponds that function as a whole.

Through use of this hydrologic analysis approach, it can be concluded that the stock ponds do have sufficient capacity to retain significant amounts of average-annual runoff within the Rosemont watershed, and thus the analysis demonstrates that the methodology presented by Tetra Tech (Tetra Tech 2017) and in the HMMP, which used the original regression methodology, are still valid. Furthermore, starting in 2007 for the Ranch Operations, and more formally since 2015, Rosemont has regularly monitored stock ponds, and there has been no evidence of stock ponds overtopping—which validates the assumptions and the results presented herein. Accordingly, the breaching of stock ponds can, in fact, be used to mitigate the reduction in stormwater flows. Based on this new analysis, approximately 7.35 AFA (7.35 = 0.32 + 6.03 + 1.00) of mitigation credit is available through breeching Gunsight Pass Tank, McCleary Canyon Stock Tank, and Rosemont Crest Tank, which is more than enough to offset the estimated 2 AFA of stormwater reduction. Additionally, Barrel Canyon East Dam Tank will be breeched as part of the HMMP so the portion of that stock pond that is unaffected by the waste rock and tailings facility becomes free-flowing, this will increase the amount of water above 7.35 AFA.

Lastly, the development of Equation 5 allows a supplemental demonstration of the overall reduction in pre- and post-mining runoff volumes to show that the reduction in stormwater flow (at the USGS SR 83 streamgage) is similar to the previous estimate as calculated in the HMMP. Assuming a pre-mining contributing drainage area of 11.6 square miles (not including areas upstream of stock ponds), Equation 5 yields 124.4 AFA ($124.4 = 16.67[11.6]^{0.82}$). Under post-mining conditions, the total anticipated contributing drainage area (as documented in the FEIS) is 11.326 square miles. Use of Equation 5 yields 122.0 AFA ($122.0 = 16.67\ [11.326]^{0.82}$). Thus, according to Equation 5, the estimated reduction in stormwater for the Rosemont watershed at the USGS SR 83 streamgage is 2.4 AFA (2.4 = 124.4 - 122.0). This estimate validates the 2 acre-feet previously calculated in the HMMP.

As the aforementioned calculations and previous estimates are based on average-annual conditions, there may be years when precipitation and runoff may exceed average-annual values. When this occurs, Rosemont is prepared to work with ADEQ to provide mitigation beyond the estimated 2 AF of reduction, if needed, by breeching additional stock ponds (after appropriate permitting) located outside the Rosemont watershed and immediately east of SR 83 in Davidson Canyon. The additional mitigation is tied to the assimilative capacity effects and water quality that EPA brought up during the 401 Certification process.

Approximately 6 additional stock ponds are located directly east of the Rosemont watershed. Using Equation 5, preliminary runoff volumes reporting to these stock ponds are estimated and are tabulated in **Table 6**. Based on Equation 5, an additional 18.0 AFA (in addition to the 7.35 AFA) is potentially available to be used for mitigation purposes.

Table 6. Preliminary Estimated Runoff Volumes Reporting to Stock Ponds Located Outside Rosemont Project Watershed

Stock Pond Name	Watershed Area Upstream of Pond (sq. mi.)	Stock Tank Capacity (AFA)	Total Estimated Runoff Volume (AFA)
ES-1	0.017	1.12	0.6
Big Pond (ES-2)	0.197	9.66	4.4
ES-3	0.060	1.10	1.6
ES-4	0.121	1.42	3.0
Adobe Tank (ES-6)	0.346	5.42	7.0
ES-7	0.048	3.14	1.4
Total	**0.790**	**21.86**	**18.0**

Note: Watershed areas are preliminary and based on USGS quad maps. Stock pond capacities are based on stage storage curves developed after survey (additional surveys may be required in the future).

The EPA (2017) also comments on "low" and "high" flows reporting to stock ponds:

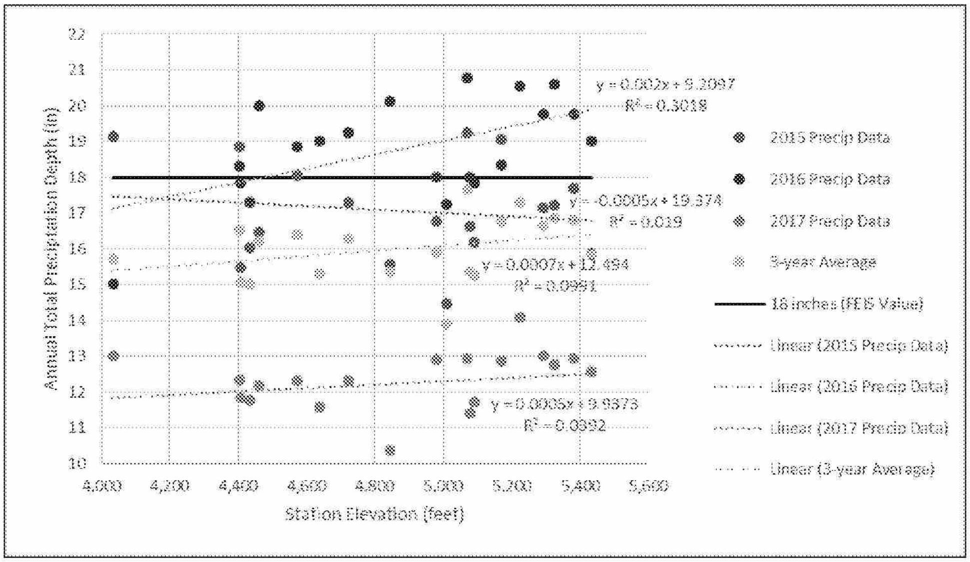
> "*The stock ponds will initially intercept and store smaller flow volumes. Smaller flows in the absence of the stock ponds would not be expected to reach the downstream segments of Barrel and Davidson canyons. Larger flows, especially if stock ponds are near or at capacity, are much more likely to reach Barrel and Davidson canyons. It is the larger flows that currently characterize site hydrology that would have the most significant effect on functioning of these waters.*"

This comment is speculative and not supported by data or analysis. Based on nine years of USGS SR 83 streamgage data, the modeled average-annual runoff is only 8.86 percent (0.0886 = 124.4 AFA/ 1,404 AFA) of the predicted average-annual runoff value from the FEIS, and likely indicates that the presence of the stock ponds has a more significant impact on the interception and storage of stormwater flows than originally thought.

The EPA (2017) also provides the following comment with regard to precipitation across the site: "*The model parameterization for average annual rainfall (i.e., 18 inches) in Equation 2 is likely significantly less than values at the higher-elevation stock pond locations.*" Here, the EPA is alluding to a presumed relationship between elevation and precipitation at the Rosemont Project, where higher elevation theoretically equates to higher precipitation. While that orographic relationship may exist on a regional scale, it is less evident on a smaller watershed scale, such as for the Rosemont Project where the watershed is a maximum of 5.5 miles wide (measured from the southwest corner of Wasp Canyon sub-watershed to the USGS SR 83 streamgage).

Exhibit 6 shows the total annual rainfall (recorded at each of the 21 gages) plotted against the gage elevation. Best fit linear regression trend lines (and equations) are also plotted. Although there are only three years of data available (from May 2015 through December 2017), four important conclusions can be made: (1) there is a high year-to-year variability in total annual precipitation (e.g., in 2016 the total average precipitation throughout the site was about 18.8 inches, but only 12.2 inches in 2017); (2) there does not appear to be any meaningful relationship showing an increase in total annual precipitation with elevation (e.g., R^2 values are all less than 0.3, which indicate that the linear regression equations do not represent any meaningful relationship); (3) there is high variability in total annual precipitation across the watershed (e.g., in several cases, gages at lower elevations had higher precipitation values than gages at higher elevations); and (4) the average value of 18 inches (used in the FEIS) is representative, and likely a conservative estimate, for the site-wide average. Thus, the average-annual rainfall value of 18 inches is valid and representative for the entire Rosemont Project watershed.

Exhibit 6. Three (3) Year Total Annual Precipitation Variability across the Rosemont Project Watershed



Lastly the EPA comments on the overall reduction in water reporting downstream:

> "*In addition, the HMMP proposes to replace the loss of stormwater flows to downstream waters based on an estimated post-mining reduction of 17.2%. Yet, during the 25-30-year active mining of the site, the proposed mine will reduce stormwater runoff by greater than 30-40%, reducing surface flow at the Davidson Canyon/Cienega Creek confluence by a minimum of 7.6 -10.2%. The proposal to remove stock tank impoundments will not replace the loss of wet water in downstream waters including the designated Outstanding Arizona Waters and prevent their degradation.*"

The updated analysis using the recent stream gage data at the USGS Stream gage demonstrates that the estimated impacts are less than what was modeled for the FEIS. While downstream flows may be affected during the active mine period, the mitigation proposed in the HMMP would result in no loss of post-mining downstream flows. However, it is expected that careful project sequencing and possible additional mitigation measures, as indicated in the mitigation plan for the 401 Certification, which includes yearly monitoring and modeling, will ensure that impacts to water quality which may be caused by flow losses can be offset by additional stock-pond elimination. Continued precipitation and flow monitoring will help determine if the impact analysis is correct, as well as what mitigation, if any, is necessary.

4. IN-LIEU FEE PROJECT

In the HMMP, Rosemont proposes to purchase credits, if needed, from an ILF project, specifically the LSPRWA project managed by the Arizona Game and Fish Department (AGFD). The EPA (2017) summarizes their comments on this proposal as follows:

> "*Purchasing advanced credits from the LSPRWA ILF Project will not provide any compensatory mitigation to offset project impacts. In summary:*
>
> - *The LSPRWA site is dissimilar in the biotic, abiotic, terrestrial and aquatic ecosystem components compared to Rosemont mine site;*
> - *The use of the ILF Program's HUC-4 geographic service area (SA) establishes a watershed scale too large to ensure that activities at the LSPRWA will effectively compensate for all aquatic resources within the HUC-4, including the Rosemont mine's environmental impacts;*
> - *The Interagency Review Team (IRT) has not approved the LSPRWA Project site. Mitigation design, crediting and the project SA have not been approved; and*
> - *The proposal to purchase advanced credits from AGFD transfers Rosemont's mitigation obligation to the state agency.*"

In keeping with the previously articulated themes, the EPA (2017) insists that because the aquatic resources at the Rosemont site and the LSPRWA site are not the same, and occur in different locations, that, "*the remote and out-of-kind mitigation proposed at the LSPRWA is not compensatory*" for Project impacts. Again, the implication is that because the proposed mitigation does not somehow undo the modeled potential impacts of the Project, that the mitigation is not of value and should not be accepted by the Corps. And again, we note that the 2008 Mitigation Rule supports compensatory mitigation that is located outside the watershed and is of a different type than the impacted aquatic resources.

It should also be noted that the 2008 Mitigation Rule emphasizes a preference for mitigation banks and ILF projects over permittee responsible projects. Because there are currently no mitigation banks in Arizona, payment to an ILF project is the Corps-preferred mitigation method.

The EPA (2017) asserts that the purchase of mitigation credits from the LSPRWA ILF project is also inappropriate because the Interagency Review Team (IRT) has not approved the mitigation design, credit cost, or the service area associated with the ILF project. They go on to assert that the HUC-4 service area established in the AGFD's enabling instrument for its ILF sponsorship is too large and should not include the Rosemont Project. However, the Rosemont Project team is aware that advance mitigation credits from the LSPRWA ILF project have already been sold for a project that is a similar distance from the ILF project and impacts similar types of aquatic resources (i.e., ephemeral washes) as the Rosemont Project. To deny Rosemont the opportunity to similarly purchase advance mitigation credits would be inconsistent with previous Corps actions.

Finally, the EPA (2017) suggests that Rosemont should be required to mitigate for impacts to another AGFD ILF project, the Cieneguita Wetlands Project. This comment relates to another memorandum prepared by the EPA regarding the effects of groundwater drawdown and the EPA's assertion of the Corps' obligation thereof. The response to that memorandum has been prepared separately and is not revisited here.

5. ADDITIONAL QUESTIONS AND COMMENTS

At the end of the memorandum, the EPA (2017) provides one additional question and one additional comment which are addressed here. The EPA (2017) text is in *italics*, the response in normal text.

1. *Was the basis for calculating the acreage of portions of Sonoita Creek to be filled based on the 5-year discharge? The 5-year discharge was used to identify the OHWM and thereby quantify the acreage of WOUS for purposes of determining reestablishment mitigation credit.*

   The estimate of acreage of Sonoita Creek to be filled was determined through mapping of the ordinary high water mark (OHWM), based on review of aerial photography and topographic maps, supplemented with field observations. The 5-year discharge was used to quantify the acreage of reestablished channel because no OHWM had yet been established for the proposed feature.

2. *The HMMP proposes 12.1 acres of channel rehabilitation along lower Sonoita Creek beginning at the Sonoita Creek – SCR Channel confluence and continuing downstream for approximately 2,511 feet. These activities will require work below the existing OHWM (i.e., areas [below] the 5-year flow line). The proposal will excavate a bench out of the existing bank to accommodate the 2-year return flow. The work will also likely result in the discharge of excavated alluvial bank material into the existing channel. In addition, three existing ephemeral tributaries flowing to the agricultural field from the east will be extended to join the reconstructed Sonoita Creek. Design drawings in the HMMP depict channel reconstruction extending upstream beyond the floodplain along existing jurisdictional watercourses. These activities will require authorization under Section 404 of the CWA and mitigation for direct and secondary impacts should be assessed and fully mitigated.*

   These mitigation activities are being addressed as part of the broader Section 404 permit for the Rosemont Project.

6. CONCLUSION

The CWA Section 404 compensatory mitigation package for the Rosemont Project represents a robust and rare opportunity to complete landscape-scale restoration of an ephemeral stream system in southern Arizona. Comments by the EPA (2017) overlook or ignore the flexibility inherent in the 2008 Mitigation Rule and the SPD guidance, and fail to acknowledge the significant opportunity afforded by this mitigation plan. The responses provided here aptly demonstrate that the mitigation plan is well considered and rooted in accepted scientific and engineering principals, and may well serve as a model for future restoration efforts in arid land systems.

7. REFERENCES

Arizona Game and Fish Department. 2011. "Guidelines for Wildlife Compatible Fencing." Arizona Game and Fish Department.

Beier, P., E. Garding, and D. Majka. 2008. "Arizona Missing Linkages: Patagonia – Santa Rita Linkage Design." *Report to Arizona Game and Fish Department.* School of Forestry, Northern Arizona University.

Betancourt, Julio L. 1990. "Tucson's Santa Cruz River and the Arroyo Legacy." *Unpublished PH.D. Dissertation.* University of Arizona.

Bowden, J. J. 2018. "San Jose de Sonoita Grant." New Mexico Office of the State Historian. http://dev.newmexicohistory.org/filedetails.php?fileID=25025.

Dolan, Cori, and Bill Mannan. 2009. "Fencing for Wildlife." *Arizona Cooperative Extension - AZ1481h.* Tucson, Arizona: University of Arizona Cooperative Extension Program. https://extension.arizona.edu/sites/extension.arizona.edu/files/pubs/az1481h.pdf.

Feth, J. H. 1947. "The Geology of Northern Canelo Hills, Santa Cruz County, Arizona." *PhD Dissertation.* University of Arizona.

Florsheim, JL, JF Mount, and A Chin. 2008. "Bank Erosion as a Desirable Attribute of Rivers." *Bioscience* 58 (6): 519–29.

Kondolf, M., and J. Ashby. 2015. "Technical Memorandum – Conceptual Design for Sonoita Creek, AZ, Technical Review Support (Order Number EP-G149-00241)." *July 27.* PG Environmental.

Levick, Lainie R., David C. Goodrich, Mariano Hernandez, Julia Fonseca, Darius J. Semmens, Juliet Stromberg, Melanie Tluczek, et al. 2008. "The Ecological and Hydrological Significance of Ephemeral and Intermittent Streams in the Arid and Semi-Arid American Southwest." *EPA/600/R-08/134, ARS/233046.* U.S. Environmental Protection Agency and USDA/ARS Southwest Watershed Research Center, 116.

Logan, Michael F. 2002. *The Lessening Stream: An Environmental History of the Santa Cruz River.* Tucson, Arizona: University of Arizona Press.

Ott, R.L., and M. Longnecker. 2010. *An Introduction to Statistical Methods and Data Analysis.* 6th ed. Belmont, California: Brooks/Cole Cenegage Learning.

Reed, S., V. Koren, M. Smith, Z. Zhang, F. Moreda, and D. J. Seo. 2004. "Overall Distributed Model Intercomparison Project Results." *Journal of Hydrology* 298: 27–60.

Sheridan, Thomas E. 2006. *Landscapes of Fraud: Mission Tumacácori, the Baca Float, and the Betrayal of the O'odham*. Tucson, Arizona: University of Arizona Press.

Stone, J. J., M. H. Nichols, D. C. Goodrich, and J. Buono. 2008. "Long-Term Runoff Database, Walnut Gulch Experimental Watershed, Arizona, United States." *Water Resources Research* 44 (W05S05).

Tetra Tech. 2010. "Technical Memorandum Mine Plan of Operations Stormwater Assessment." *Document No. 062/10-320871-5.3, Prepared for Rosemont Copper Company*. Tucson, Arizona: Tetra Tech.

_____. 2017. "Rosemont Stock Ponds – Preliminary Potential Runoff Volumes Calculation Technical Memorandum." *Technical Memorandum Dated July 14, 2017*. Tucson, Arizona: Tetra Tech.

U.S. Army Corps of Engineers. 2015. "Final 2015 Regional Compensatory Mitigation and Monitoring Guidelines." South Pacific Division.

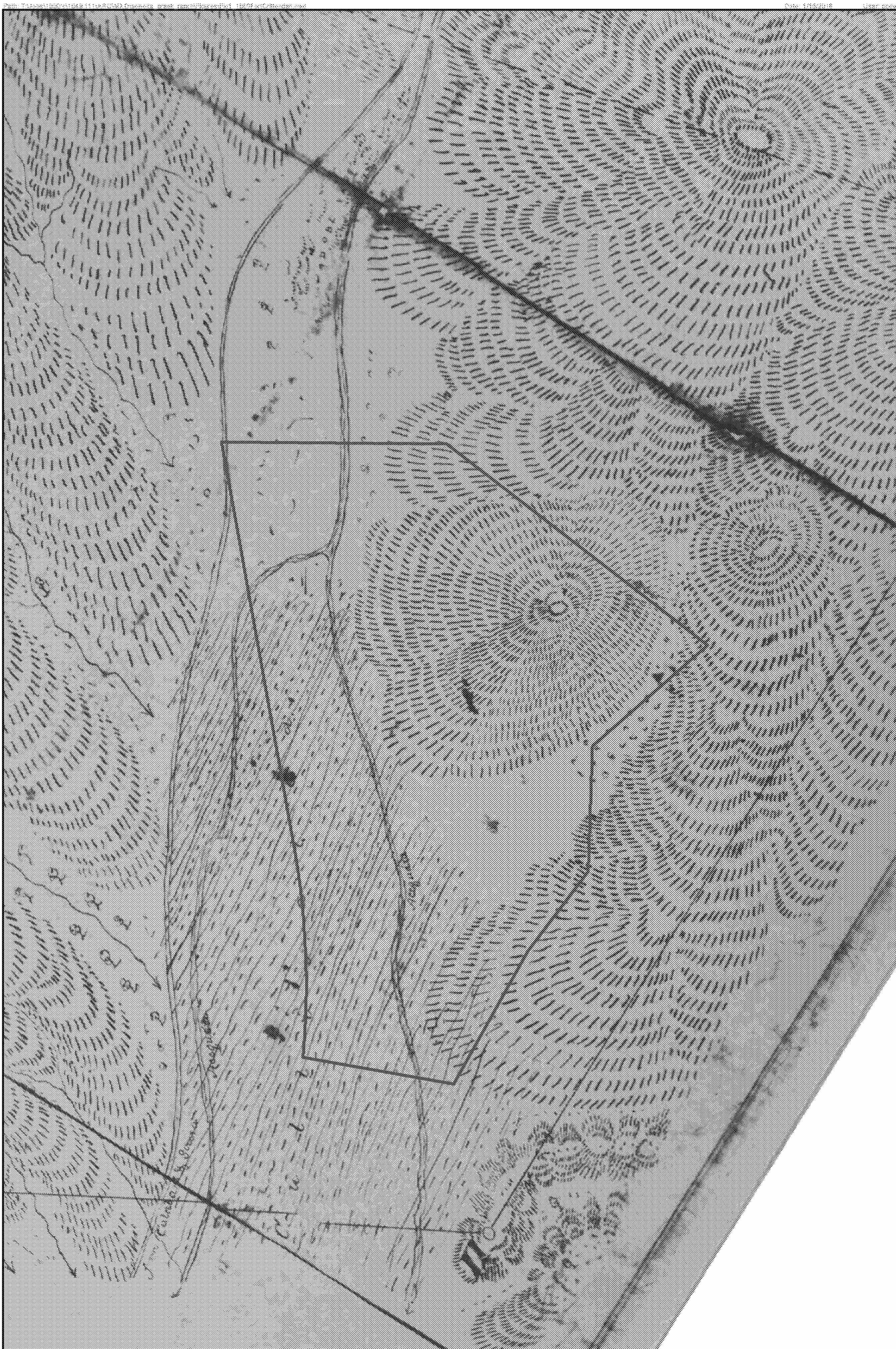
U.S. Environmental Protection Agency. 2017. "EPA Analysis of the Final Habitat Mitigation and Monitoring Plan [HMMP] Permit NO. SPL-2008-00816-MB Rosemont Copper Project Dated September 12, 2017." *Memorandum Dated October 5, 2017, Revised November 30, 2017*.

Webb, Robert H., Stanley A. Leake, and Raymond M. Turner. 2007. *The Ribbon of Green: Change in Riparian Vegetation in the Southwestern United States*. Tucson, Arizona: University of Arizona Press.

WestLand Resources Inc. 2012. "Rosemont Copper Project: Potential Effects of the Rosemont Project to Jaguar and Proposed Jaguar Critical Habitat." *Prepared for Rosemont Copper Company*. Tucson, Arizona: WestLand Resources, Inc.

APPENDIX A

Sonoita Creek Ranch Property (North Parcel) Depicted on 1869 Fort Crittenden Map



Legend

Sonoita Creek Ranch Property

T21S, R16E, Portions of Sections 3 and 4
Santa Cruz County, Arizona
Projection: UTM NAD83, Zone 12
Data Source: 1869 Fort Crittenden Map

WestLand Resources

0 300 600 Feet

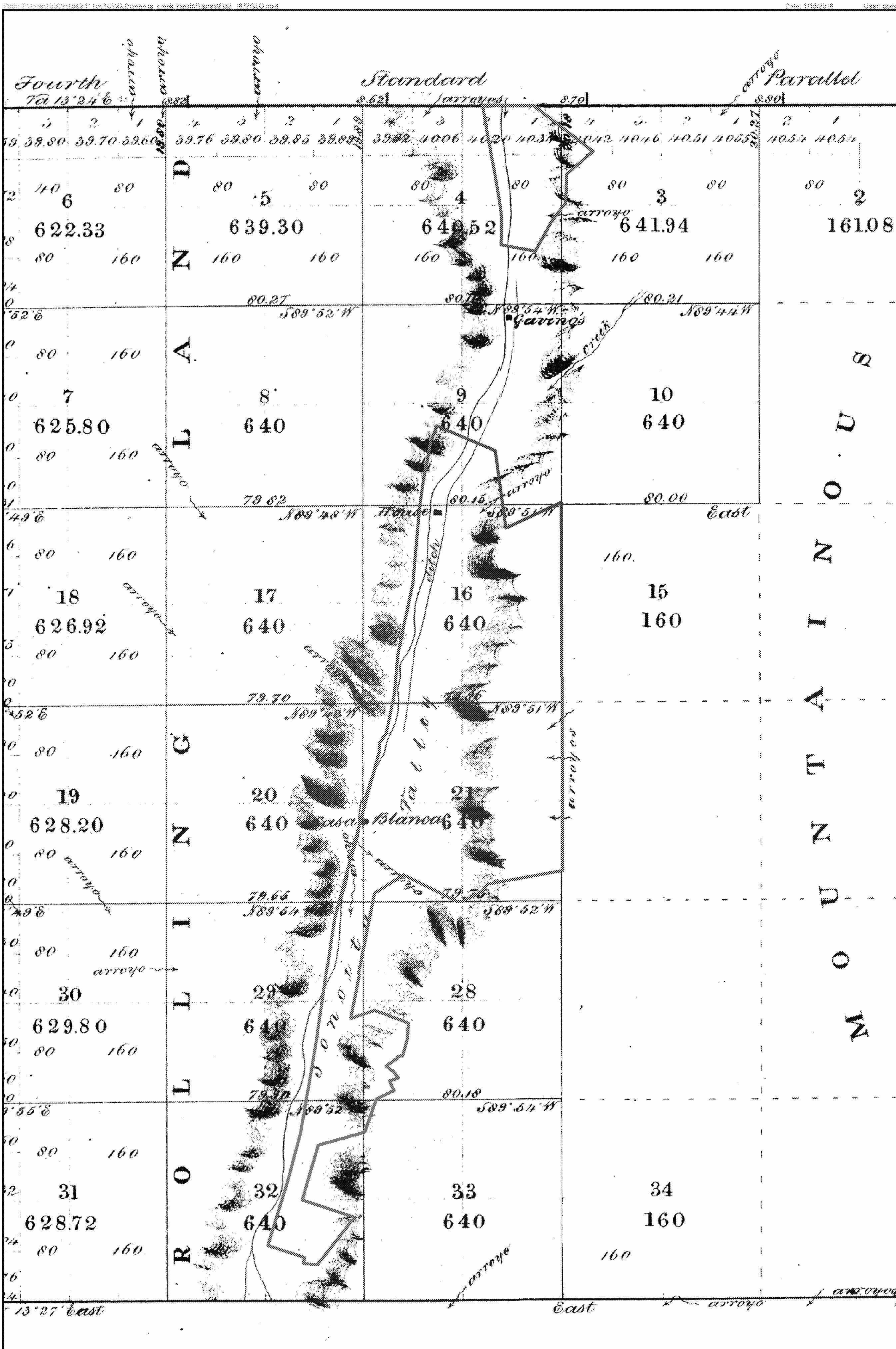
0 150 300 Meters

N

Appendix A. Sonoita Creek Ranch Property (North Parcel) Depicted on 1869 Fort Crittenden Map

APPENDIX B

Sonoita Creek Ranch Property Depicted on 1877 General Land Office Plat



Legend

Sonoita Creek Ranch Property

T21S, R16E, Portions of Sections 3, 4, 9, 16, 20, 21, 28, 29, 32, and 33
Santa Cruz County, Arizona
Projection: UTM NAD83, Zone 12
Data Source: Township 21 South Range 16 East 1877 GLO Plat

0 0.5 1 Miles

0 0.5 1 Kilometers

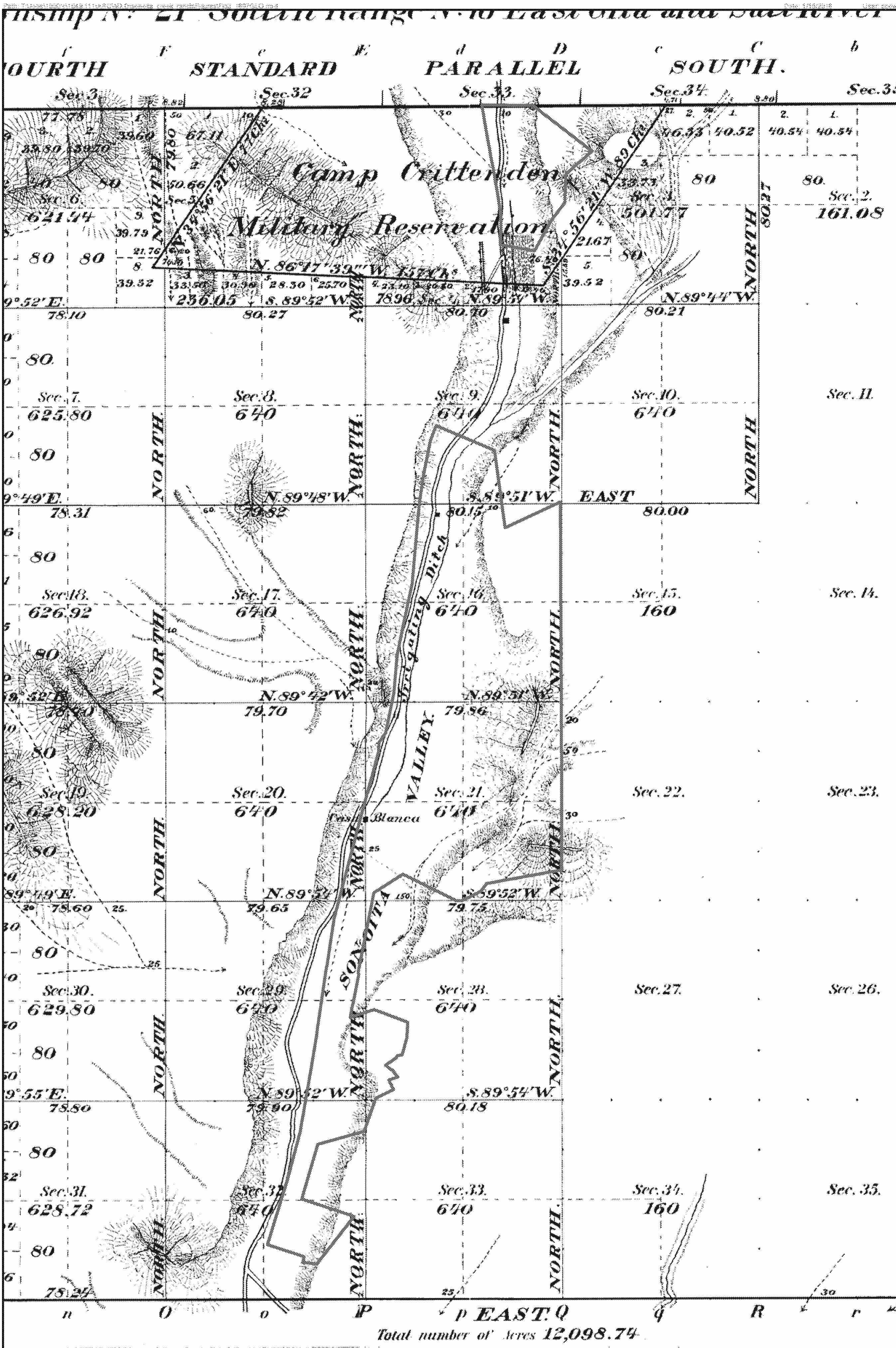
N

WestLand Resources

Appendix B. Sonoita Creek Ranch Property Depicted on 1877 General Land Office Plat

APPENDIX C

Sonoita Creek Ranch Property Depicted on 1897 General Land Office Plat



Legend

Sonoita Creek Ranch Property

T21S, R16E, Portions of Sections 3, 4, 9, 16, 20, 21, 28, 29, 32, and 33
Santa Cruz County, Arizona
Projection: UTM NAD83, Zone 12
Data Source: Township 21 South Range 16 East 1897 GLO Plat

0 0.5 1 Miles

0 0.5 1 Kilometers

N

WestLand Resources

Appendix C. Sonoita Creek Ranch Property Depicted on 1897 General Land Office Plat